National Aeronautics and
Space Administration

HIGH-END COMPUTING CAPABILITY PORTFOLIO

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February 10, 2022

Request Management System Version 3.1 Released

- The HECC and NCCS Cloud teams collaborated with the RMS team to release version 3.1 of the Request Management System (RMS) on December 14, 2022.
- Version 3.1 concentrated on providing functionality that enables users to request HECC-supported cloud computing resource allocations.
- This work aims to better support NASA's Science Mission Directorate's (SMD) vision of evolving data and computing systems toward hybrid HPC and cloud computing environments and core services.
- The new RMS feature allow users to:
  - Perform general requests for HECC and NCCS commercial cloud resources.
  - Requests can specify cloud resource compute instance types, such as general purpose, compute- or memory-optimized, accelerated computing, etc.
- Future RMS versions will enhance and refine cloud allocations resource requests.

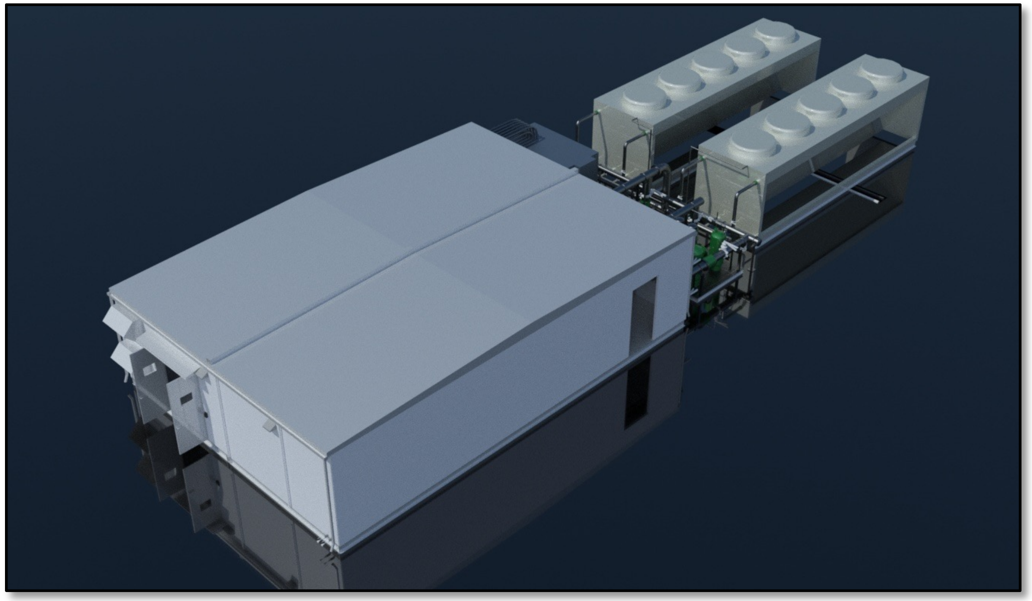
IMPACT: The new capability will enable HEC to communicate cloud service offerings and allow the HEC user community to formally request cloud resources, supporting NASA's Data and Computing System Evolution vision of hybrid HPC and cloud computing HPC environments.

Banner announcement of RMS 3.1 release, cloudy skies over Sudan ISA, *credit ESA/NASA*

Compute Module 2 Achieves Design Milestone

- Engineers from the NASA Advanced Supercomputing Division and the NASA Ames Facilities Engineering Branch approved the 45% design progress drawings for the Modular Supercomputing Facility's (MSF) Compute Module 2 (CM2).
- The module manufacturer, Avail Enclosure Systems, received approval on their design submittal on January 20, 2023.
  - Avail was awarded the CM2 design, manufacture, and installation contract in October 2022.
- Avail's submittal focused on the CM2 exterior design, interior layout, electrical distribution, and mechanical cooling equipment.
- Approval of the CM2 45% design allows Avail to begin detailed design efforts to be presented in the 90% design progress review and permit submittal, scheduled for April 2023.
- The 45% design also allows Avail to finalize contracts with their suppliers, as key items were approved for procurement.
- CM2 is the second modular data center to be installed at the MSF and will host the next expansion of the Aitken supercomputer in early 2024.

IMPACT: The Compute Module 2 at the Modular Supercomputing Facility will double the size of the Aitken supercomputer, providing additional computing resources to meet the requirements of the NASA High-End Computing user community.



Graphical rendering of the Compute Module 2 and support infrastructure, which will be installed at the Modular Supercomputing Facility at NASA's Ames Research Center. *Avail Enclosure Systems*

New DDN Systems Increase HECC Storage Capacity

- Three new DataDirect Networks (DDN) storage systems were installed and are nearing completion of acceptance testing:
  – Two 19 petabyte (PB) systems and one 9.3 PB system.
- The 9.3-PB system will be dedicated for use by the Visualization and Data Analysis team.
- The current visualization filesystem (nobackupp1) will be reused for the NAS Data Portal.
- With the addition of these new filesystems, the total Lustre capacity has increased by ~75%—from 62.7 PB to 110 PB.
- The new systems are directly attached to Aitken and Pleiades.
- The direct route to Aitken is two times faster than going through the Pleiades and Lustre routers (see next slide).
- The change to how Aitken connects to the DDN filesystems not only improves the Aitken-to-DDN performance, but also improves the connection to all of the compute clusters to all of the filesystems by reducing congestion on the InfiniBand networks.

IMPACT: The new DDN storage systems are significantly more capable of keeping pace with the increasing storage requirements of HECC users.

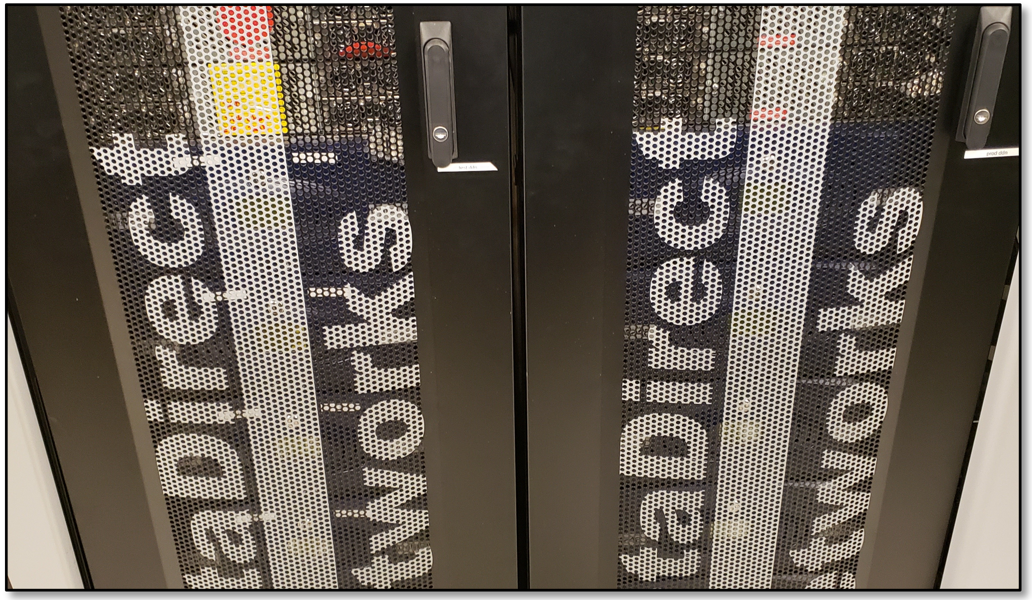


Photo of the DataDirect Networks storage systems at the NASA Advanced Supercomputing facility. *Don Story, NASA/Ames*

HECC I/O Infrastructure Reconfiguration Completed

- The HECC Systems team's InfiniBand reconfiguration was completed, eliminating bottlenecks in I/O bandwidth from the Aitken cluster to the DataDirect Network (DDN) storage systems.
- The old I/O path used Lustre routers and Pleiades I/O fabric to route Aitken traffic to the DDN storage.
- The new path directly connects the DDN storage to the Aitken cluster.
- This change frees up available bandwidth to non-DDN filesystems.
- The direct connection increased I/O performance from the Aitken cluster to the DDN storage by more than 2X.

IMPACT: The HECC I/O infrastructure reconfiguration allows users to fully utilize the I/O bandwidth of the DDN storage.

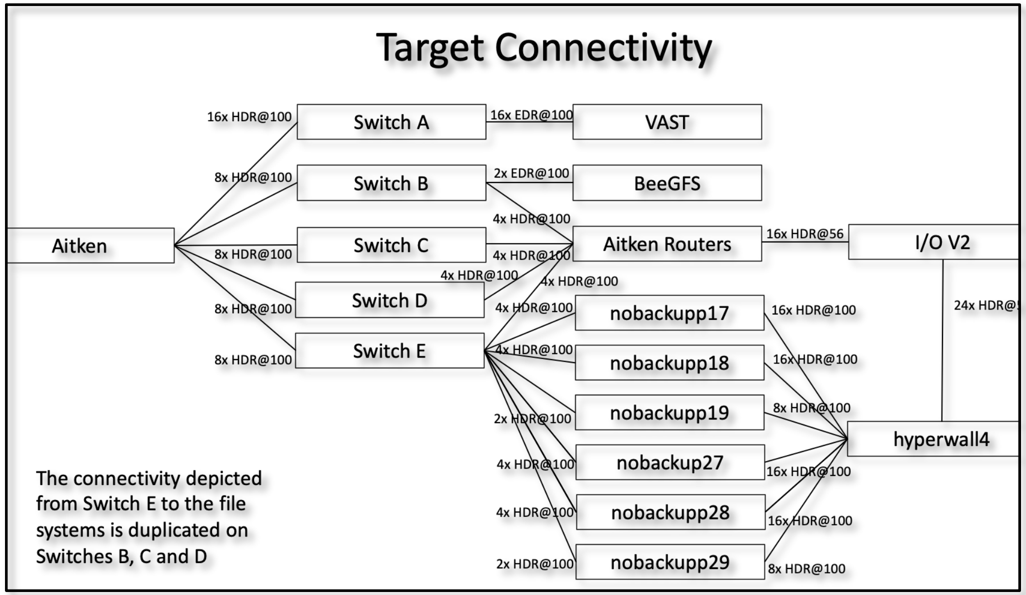


Diagram of the updated I/O infrastructure connecting the Aitken supercomputer to the DataDirect Network storage systems.

NASLAN User Access Switches Upgraded

- The HECC Networks team completed upgrading end-of-life local area network (NASLAN) access switches in the NASA Advanced Supercomputing facility network rooms in building N258.
- The new hardware provides the following benefits:
  - Replaces the approximately 10-year-old network infrastructure with up-to-date, fully supported, more power efficient switches.
  - Improves scalability with the ability to dynamically add up to 8 stack members (up to 384 available access ports per switch stack).
- In addition, the enhanced system capabilities provide improved performance for local users at the NAS facility in Building N258.
  - Increased system resources (faster CPU, increased memory).
  - Improved (640 gigabit-per-second) switching capacity.
- This upgrade enables the NASLAN user access network infrastructure to scale to either 25- or 40-gigabit-per second-uplinks in the future.

IMPACT: The upgrade to NASLAN provides users located in the NASA Advanced Supercomputing facility with an up-to-date, fully supported network infrastructure, including increased capabilities, power efficiency, and scalability.

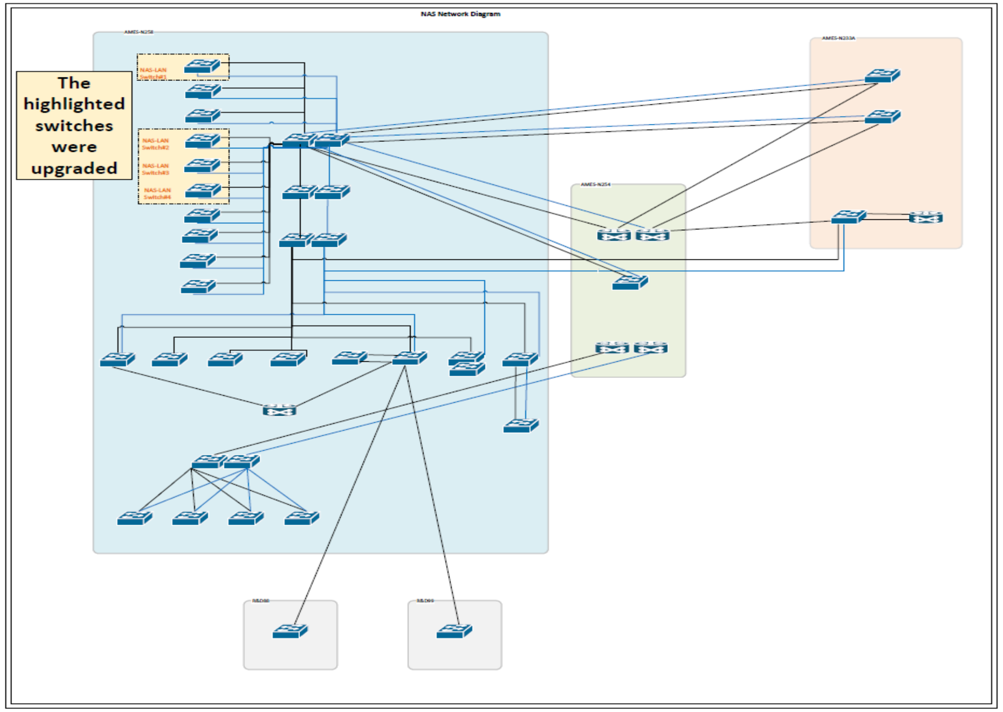


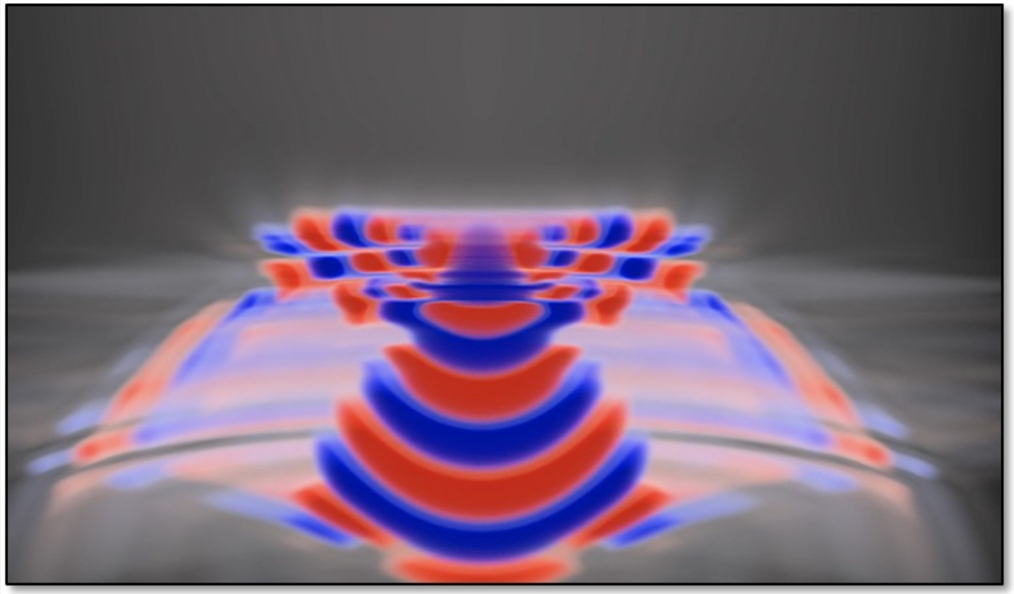
Diagram of the NASLAN user access switches that were replaced.

Simulating Sunquakes: The Impact of Flares on the Sun*

- Researchers at New Jersey Institute of Technology (NJIT) are simulating how solar flares generate sunquakes—strong solar flare generated waves that travel through the entire Sun.
- The NJIT team studies how the Sun responds to the energy released by solar flares and how this corresponds to observations.
- Although they expected flares with more high-energy particles to generate the strongest sunquakes, simulation results show that flares with a *lower* minimum particle energy are more effective at generating sunquakes.
  - These particles can't penetrate as deeply into the Sun, yet can accelerate the thin layers of the solar atmosphere to very high speeds—efficiently transferring their energy into sunquakes that travel throughout the Sun.
  - Flares with lower-energy particles tended to generate strong acoustic-gravity waves (compared to the normal pressure waves), which haven't been measured in observed sunquakes.
- Findings from simulations run indicate that a "sweet spot" exists in terms of the particle energies in flares that cause some flares to generate sunquakes while others do not.

** HECC provided supercomputing resources and services in support of this work.*

IMPACT: The results of this work give the heliophysics community a deeper understanding of how energy is transported during a solar flare. HECC resources are key to working with the very large data files generated.



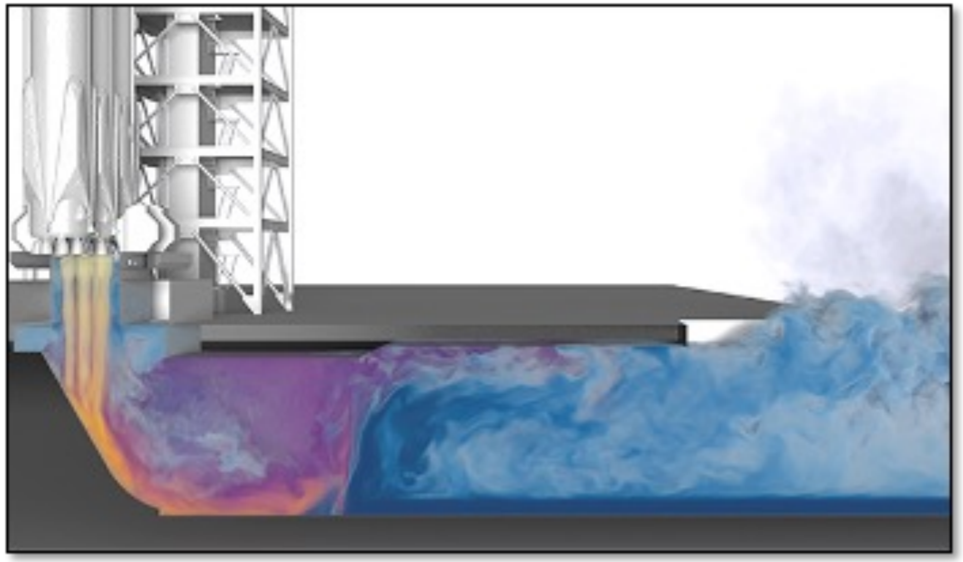
Video showing a cross-section of the Sun during and after flare heating. The waves that initially travel upward pass through the thinner layers of the Sun's atmosphere where the sound speed is much greater, so the wavefront moves more quickly than the downward wavefront. *John Stefan, New Jersey Institute of Technology; Nina McCurdy, NASA/Ames*

Multiphase Simulations of KSC's Launch Environment*

- To support NASA's Artemis missions launching aboard the new Space Launch System (SLS), as well as launches by the agency's commercial partners, the Launch Ascent and Vehicle Aerodynamics (LAVA) team at Ames is pushing the state of the art for numerically predicting ignition overpressure (IOP) waves in launch environments.
- Using the Electra and Aitken supercomputers, the team developed a new computational approach for simulating multiphase (gas-liquid) flows that can robustly solve the extreme flow conditions in the launch environment and still accurately capture the acoustic IOP wave propagation.
- In collaboration with the Launch Services Program (LSP) at KSC, the LAVA team used this new capability to simulate the Space Test Program (STP)-2 launch, which flew on SpaceX's Falcon Heavy rocket from KSC's Launch Complex 39A. The simulation showed excellent agreement with flight data and was a significant breakthrough for computational IOP prediction.
- The LAVA team is applying this multiphase capability to carry out challenging realistic launch simulations, in order to study acoustic wave propagation from the complex interactions of rocket engine plumes with the flame trench and water-based sound suppression systems.
- The code is currently being modified to run on GPU accelerators to enhance turnaround time and leverage new compute architectures.

** HECC provided supercomputing resources and services in support of this work.*

IMPACT: The LAVA team continuously improves and updates NASA's launch environment simulation capability by routinely enhancing the numerical methods, including accuracy, robustness, and time-to-solution. As a result, CFD data are being used to guide project engineers in evaluating real-time, mission-critical design decisions.



Video showing exhaust and liquid water mass fractions for a Falcon Heavy simulation at Launch Complex 39A. For the liquid water, dark blue is high and light blue is low. The exhaust plume mass fraction is colored so that high is yellow and low is purple. *Jordan Angel, Timothy Sandstrom, NASA/Ames*

Papers

- "**Machine Learning Strategy for Subgrid Modeling of Turbulent Combustion Using Linear Eddy Mixing Based Tabulation**," R. Ranjan, et al., Lecture Notes in Energy, vol. 44 (Springer), published online January 2, 2023. *
  https://link.springer.com/chapter/10.1007/978-3-031-16248-0_7
- "**The K2 & TESS Synergy II: Revisiting 26 Systems in the TESS Primary Mission**," E. Thygesen, et al., arXiv:2301.01306 [astro-ph.EP], January 3, 2023. *
  https://arxiv.org/abs/2301.01306
- "**TESS Discovery of Twin Planets Near 2:1 Resonance around Early M-Dwarf TOI 4342**," E. Tey, et al., arXiv:2301.01370 [astro-ph.EP], January 3, 2023. *
  https://arxiv.org/abs/2301.01370
- "**Detecting Interference Between Applications and Improving the Scheduling Using Malleable Application Proxies**," A. Cascajo, et al., Lecture Notes in Computer Science, vol. 13387 (Springer), January 4, 2023. *
  https://link.springer.com/chapter/10.1007/978-3-031-23220-6_9
- "**The Relationship between Age, Metallicity, and Abundances for Disk Stars in a Simulated Milky Way**," A. Carrillo, et al., The Astrophysical Journal, vol. 942, no. 1, January 4, 2023. *
  https://iopscience.iop.org/article/10.3847/1538-4357/aca1c7/meta
- "**Formation of Magnetic Switchbacks Observed by Parker Solar Probe**," G. Toth, et al., arXiv:2301.02572 [astro-ph.SR], January 6, 2023. *
  https://arxiv.org/abs/2301.02572

** HECC provided supercomputing resources and services in support of this work*

Papers (cont.)

- "**A Second Earth-Sized Planet in the Habitable Zone of the M Dwarf, TOI-700**," E. Gilbert, et al., arXiv:2301.03617 [astro-ph.EP], January 9, 2023. *
  https://arxiv.org/abs/2301.03617
- "**Quantification of Aquarius, SMAP, SMOS, and Argo-Based Gridded Sea Surface Salinity Product Sampling Errors**," S. Fournier, et al., Remote Sensing, vol. 15, issue 2, published online January 10, 2023. *
  https://www.mdpi.com/2072-4292/15/2/422
- "**Nonlinear Fast Magnetosonic Waves in Solar Prominence Pillars**," L. Ofman, et al., arXiv:2301.04503 [astro-ph.SR], January 11, 2023. *
  https://arxiv.org/abs/2301.04503
- "**GJ 806 (TOI-4481): A Bright Nearby Multi-Planetary System with a Transiting Hot, Low-Density Super-Earth**," E. Palle, et al., arXiv:2301.06873 [astro-ph.EP], January 17, 2023. *
  https://arxiv.org/abs/2301.06873
- "**Resonant Diurnal Internal Tides in the North Atlantic, Part II: Modeling**," B. Dushaw, D. Menemenlis, Geophysical Research Letters, published online January 17, 2023. *
  https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2022GL101193
- "**HIP 33609 b: An Eccentric Brown Dwarf Transiting a V=7.3 Rapidly Rotating B-Star**," N. Vowell, et al., arXiv:2301.09663 [astro-ph.EP], January 23, 2023. *
  https://arxiv.org/abs/2301.09663

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Papers (cont.)

- **AIAA SciTech 2023 Forum**, National Harbor, MD, January 23-27, 2023.
  - ”**Sensitivity of External Emission Spectroscopy for Hypersonic Vehicle Control**,” M. Chern, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1370
  - “**Joint Acceptance Attenuation Factor of Integrated Pressure with Unsteady Pressure-Sensitive Paint Measurements**,” J. Li, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0637
  - “**Operational Techniques in Microgravity for Cryogenic Fluid Management**,” B. Hoffman, J. Brodnick. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1217
  - “**A Computational Study of Plume Modeling for Space Launch System Abort Scenarios**,” J. Boustani, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0239
  - “**Development of a Hybrid Particle-Continuum Solver for Studying Plume Expansion into Rarefied Flows**,” O. Tumuklu, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0073
  - “**Development of a Cartesian Cut-Cell Solver for Viscous Flows**,” A. Kleb, K. Fidkowski, J. Martins. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1795
  - “**Measurements and Computations of Natural Transition on the NASA Juncture-Flow Model with a Symmetric Wing**,” A. Leidy, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0441
  - “**A Multi-Limiter Method for Simulating Complex Flows on Large Grids**,” P. Cizmas, J. Schoppe. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1900

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Papers (cont.)

- **AIAA SciTech 2023 Forum**, National Harbor, MD, January 23-27, 2023 (cont).
  - “**Delayed Detached Eddy Simulation of Axisymmetric Turbulent Shock Wave Boundary Layer Interaction at Mach 2.5**,” J.-P. Mosele, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1427
  - “**Validation of Cryogenic Propellant Tank Self-Pressurization**,” H. Yang, C. Patel, B. Williams. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1411
  - “**Mixed-Element USM3D Contributions to the 4th AIAA High Light Prediction Workshop**,” M. Bozeman, M. Pandya. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1759
  - “**Numerical Investigation of Fluid-Ablation Interactions for a Mach 5.3 Transitional Boundary Layer Flow Over a 13 Degree Cone**,” S. Dungan, C. Brehm, J. McQuaid, A. Zibitsker, A. Martin. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0476
  - “**Wall-Modeled LES of the Three-Dimensional Speed Bump Experiment**,” P. Iyer, M. Malik. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0253
  - “**NASA’s Unsteady Pressure-Sensitive Paint Research and Operational Capability Developments**,” N. Roozeboom, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0636
  - “**A Multi-Architecture Approach for Implicit Computational Fluid Dynamics on Unstructured Grids**,” G. Nastac, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1226
  - “**Computational Study on Fully Coupled Combustor-Turbine Interactions**,” K. Miki, T. Wey, J. Moder. *
    https://arc.aiaa.org/doi/full/10.2514/1.B38501

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Presentations

- **241st Meeting of the American Astronomical Society**, Seattle, WA, January 8-12, 2023.
  - “**3D Realistic Modeling of Solar-Type Stars to Characterize the Stellar Jitter**,” I. Kitiashivili, S. Granovsky, A. Wray. *https://www.cambridge.org/core/journals/proceedings-of-the-international-astronomical-union/article/3d-realistic-modeling-of-solartype-stars-to-characterize-the-stellar-jitter/1C2B1974C6191388F96F98CF25FF536F*
  - “**Modeling Stellar Jitter for the Detection of Earth-Mass Exoplanets via Precision Radial Velocity Measurements**,” S. Granovsky, et al. *https://www.cambridge.org/core/journals/proceedings-of-the-international-astronomical-union/article/modeling-stellar-jitter-for-the-detection-of-earthmass-exoplanets-via-precision-radial-velocity-measurements/65E5CA6A73EB1539DCFF65A17BC5756B*
- “**Progress in Automation of Overset Structured Mesh Generation**,” W. Chan, Boeing CFD Community of Excellence Lecture Series, Virtual Meeting, January 13, 2023.
- “**Remote Streaming & Visualization of ECCO Data with Jupyter Notebook and IDX**,” N. McCurdy, NASA ECCO Annual Meeting 2023, Pasadena, CA, January 25, 2023.
- **AIAA SciTech 2023 Forum**, National Harbor, MD, January 23-27, 2023.
  - “**Fluid-Structure Interaction Simulations of the ASPIRE SR03 Supersonic Parachute Flight Test** ,” F. Cadieux, J. Angel, M. Barad, C. Kiris. *https://arc.aiaa.org/doi/abs/10.2514/6.2023-1336*
  - “**High-Fidelity Simulations of a Tiltwing Vehicle for Urban Air Mobility**,” D. Garcia Perez, P. Ventura Diaz, S. Yoon. *https://arc.aiaa.org/doi/abs/10.2514/6.2023-2282*

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Presentations (cont.)

- **AIAA SciTech 2023 Forum**, National Harbor, MD, January 23-27, 2023 (cont).
  - "**Evaluation of Voronoi Meshes for Large Eddy Simulations of High Lift Aerodynamics**," E. Sozer, A. Ghate, G. Kenway, M. Barad, et al.
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0255
  - "**Preliminary Assessment of a Distributed Electric Propulsion System for the SUSAN Electrofan**," L. Machado, T. Chau, G. Kenway, et al.
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1748
  - "**Parallel Mesh Adaptation for Unsteady Blast Simulations on Cartesian Meshes**," W. Spurlock, M. Aftosmis, J. Chiew, M. Nemec.
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1792
  - "**Unsteady RANS and Scale Resolving Simulations of Open Rotor Noise**," E. Dumlupinar, J. Housman, G. Kenway, C. Kiris.
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0028
  - "**LAVA CFD Analysis of the Check Standard Model with the Langley Unitary Plan Wind Tunnel**," J. Koch, J. Housman, C. Kiris.
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-1455
  - "**Launch Vehicle Ascent CFD for the Space Launch System**," D. Dalle, S. Rogers, J. Meeroff, A. Burkhead, D. Schauerhamer, J. Diaz.
    https://arc.aiaa.org/doi/abs/10.2514/6.2023-0237

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Presentations (cont.)

- **AIAA SciTech 2023 Forum**, National Harbor, MD, January 23-27, 2023 (cont).
    - "**Advances in Space Launch System Booster Separation CFD**," J. Meeroff, D. Dalle, S. Rogers, A. Burkhead, D. Schauerhamer, J. Diaz.
      https://arc.aiaa.org/doi/abs/10.2514/6.2023-0238
    - "**Aerodynamic Assessment of Surface-Normal Active Flow Control for Lift Enhancement on the High-Lift Common Research Model**," S. Shosseini, C. Van Dam, S. Pandya.
      https://arc.aiaa.org/doi/abs/10.2514/6.2023-0433

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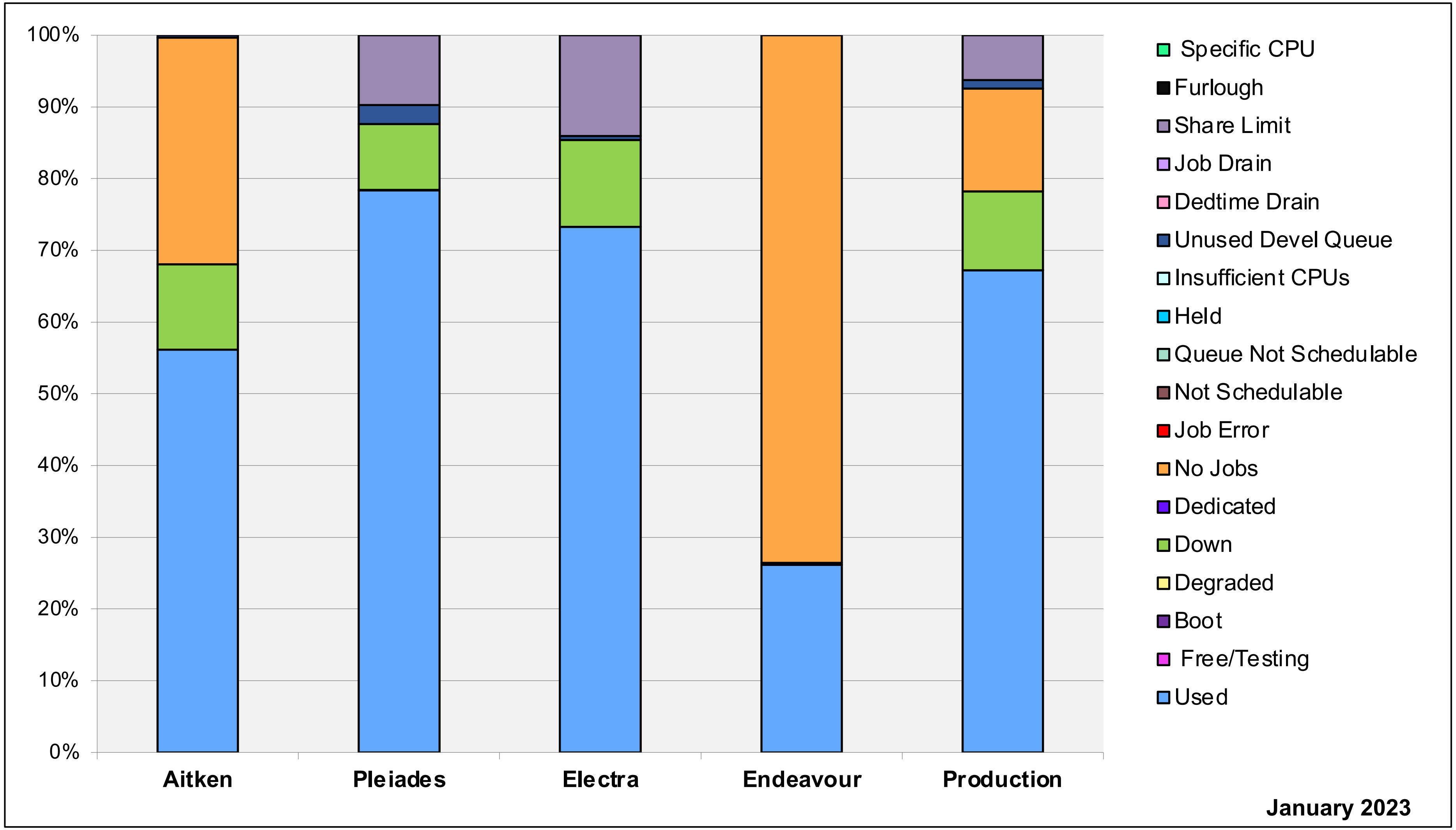
News and Events

- **The Reach of an Asteroid Tsunami: Examining the Devastating Power of a Natural Disaster**, *IBA Word Tour: Oceans*, January 21, 2023—Hydrocode simulations run on the Pleiades supercomputer have helped simulate the potential reach of an asteroid tsunami, including its range of destruction and the factors that affect its magnitude. *https://ibaworldtour.com/the-reach-of-an-asteroid-tsunami-examining-the-devastating-power-of-a-natural-disaster/*

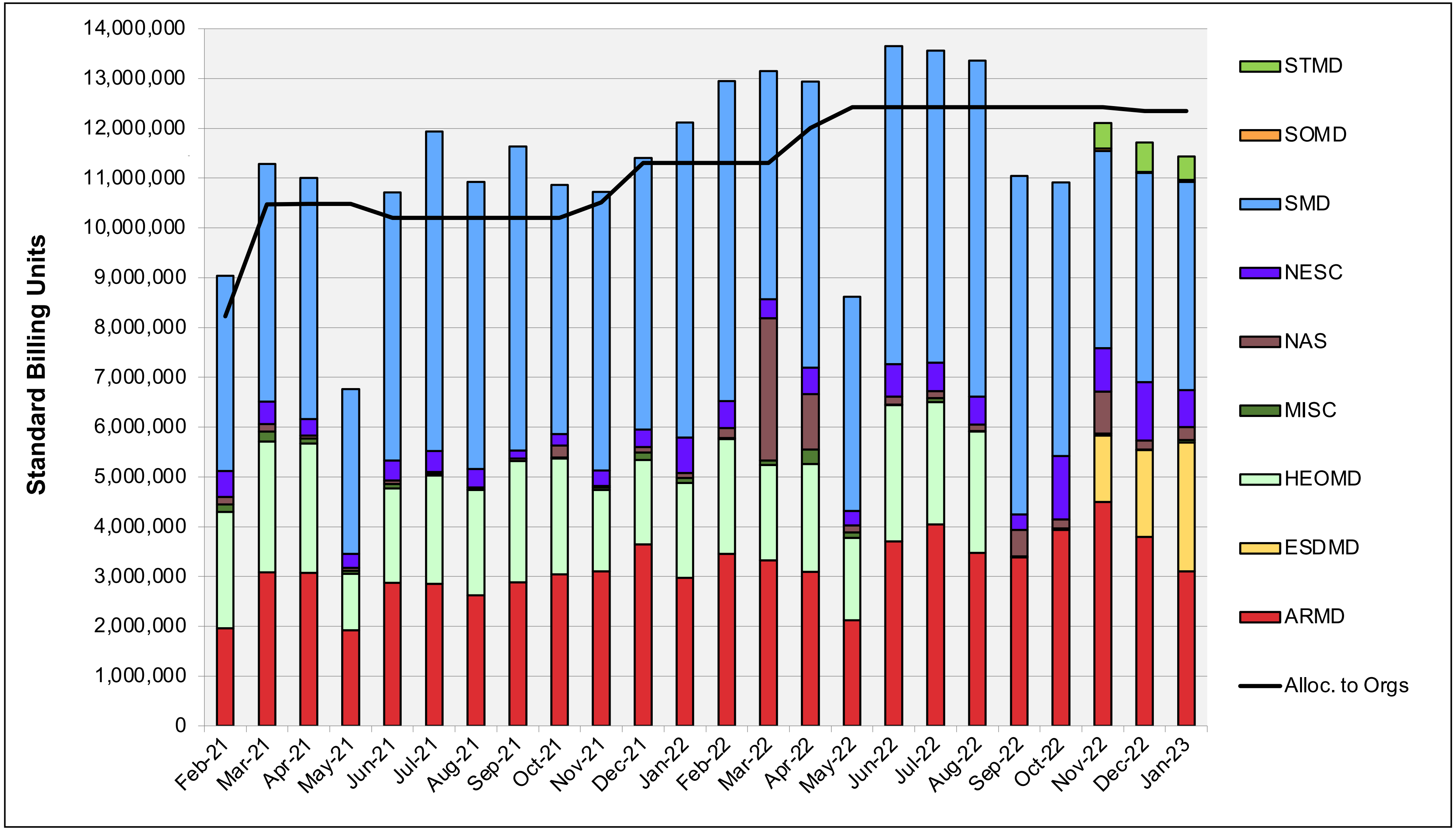
News and Events: Social Media

- **Coverage of NAS Stories**
  - Mars Viking 1 Landing Site Deposit Models:
    - NAS: Twitter 2 retweets, 9 likes, 656 views; Facebook 22 likes, 5 shares.
  - NASA's Day of Remembrance:
    - NAS: Twitter 4 retweets, 12 likes, 1,738 views.

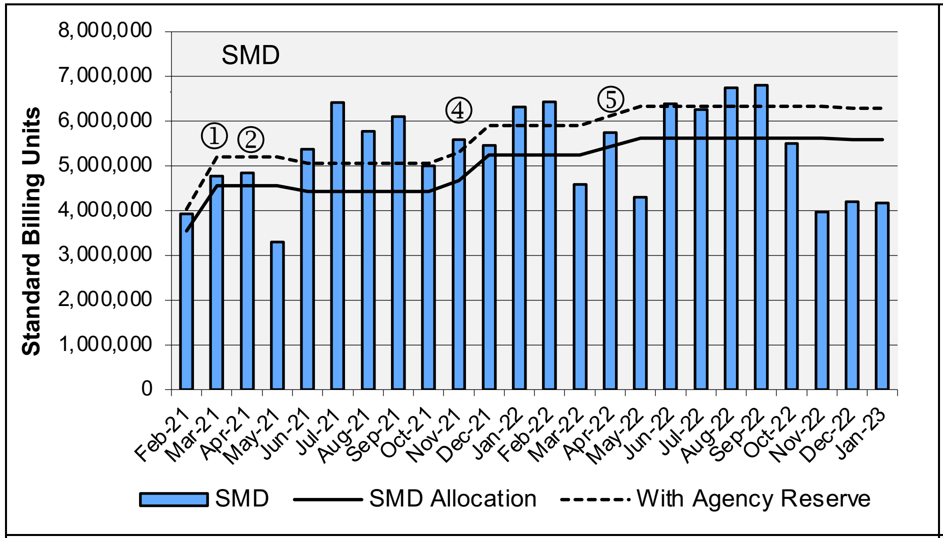
HECC Utilization

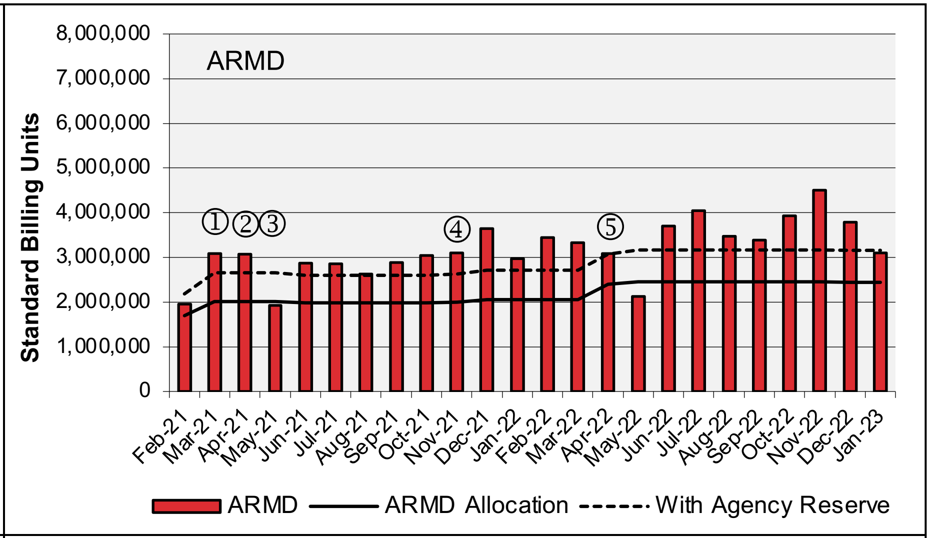


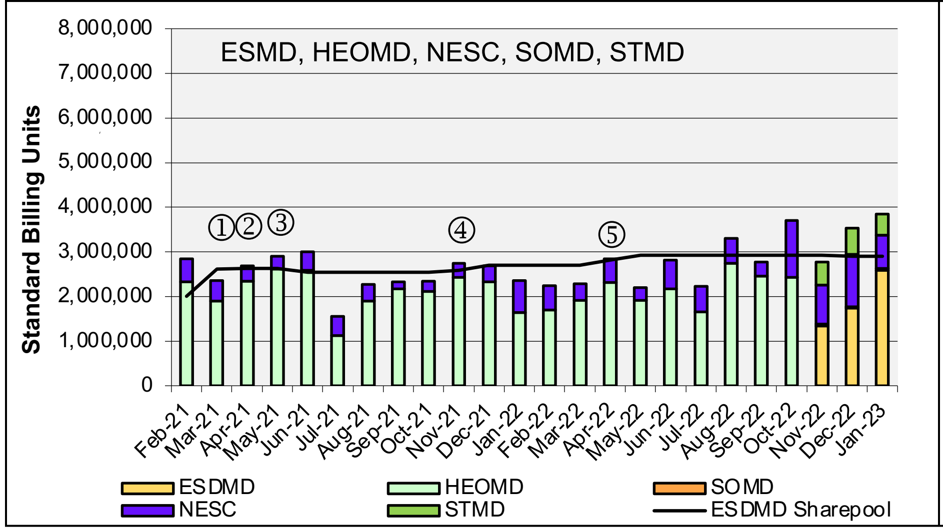
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







① 8 Rome Apollo racks introduced into Aitken

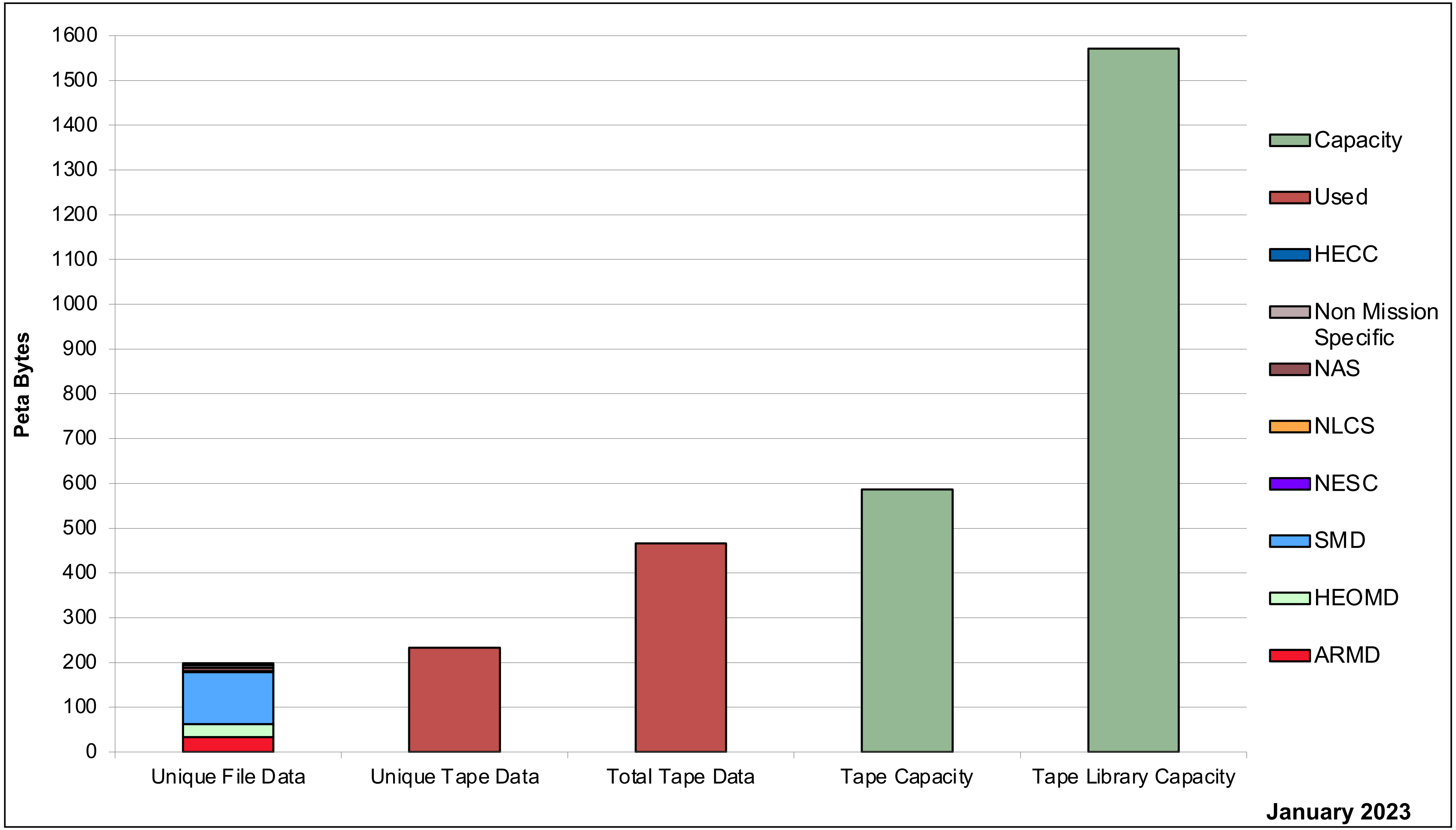
② Endeavour replaced with new hardware

③ Merope retired

④ 4 Rome Apollo Racks added to Aitken

⑤ 4 Rome Apollo Racks added to Aitken

Tape Archive Status



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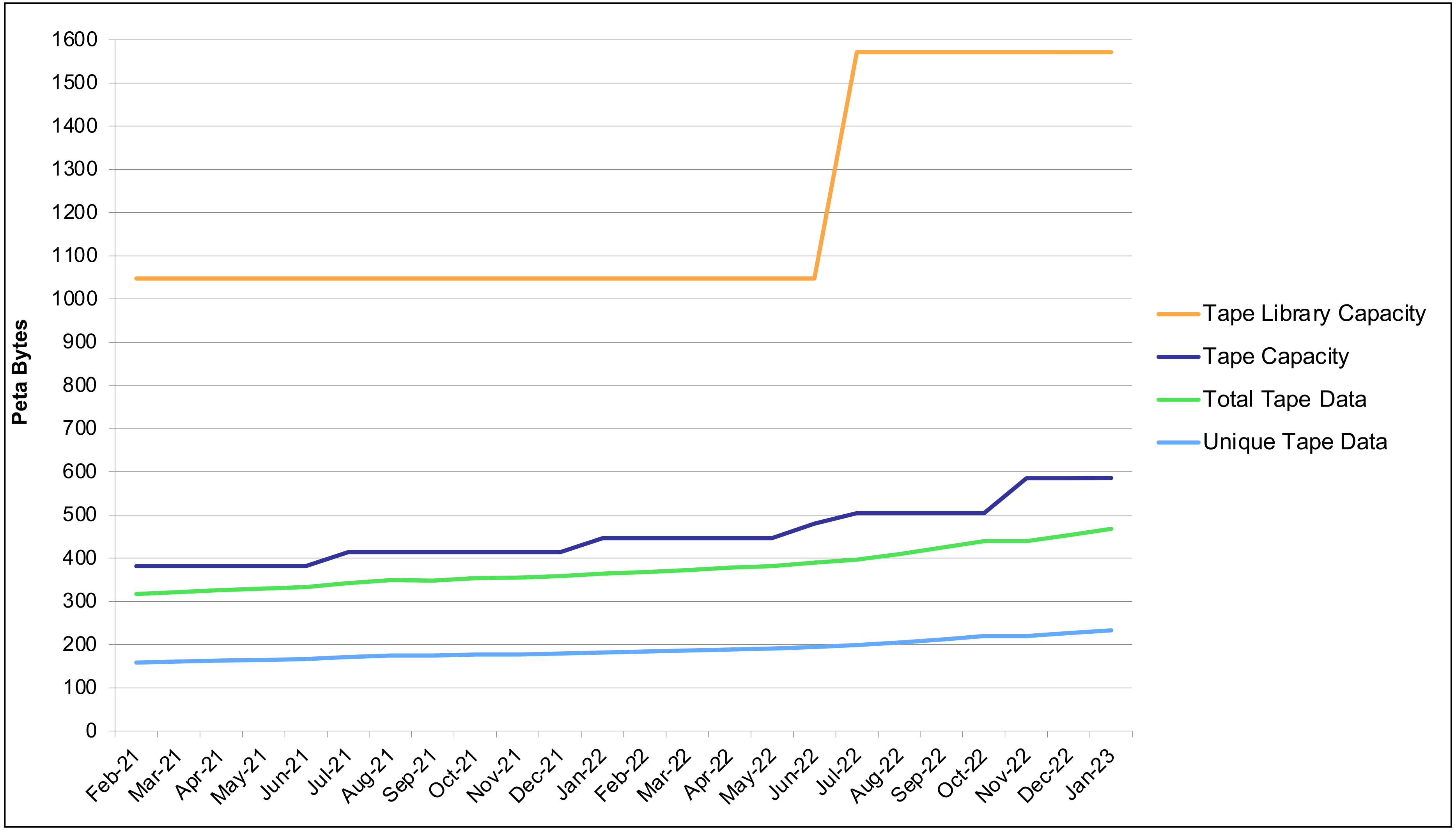
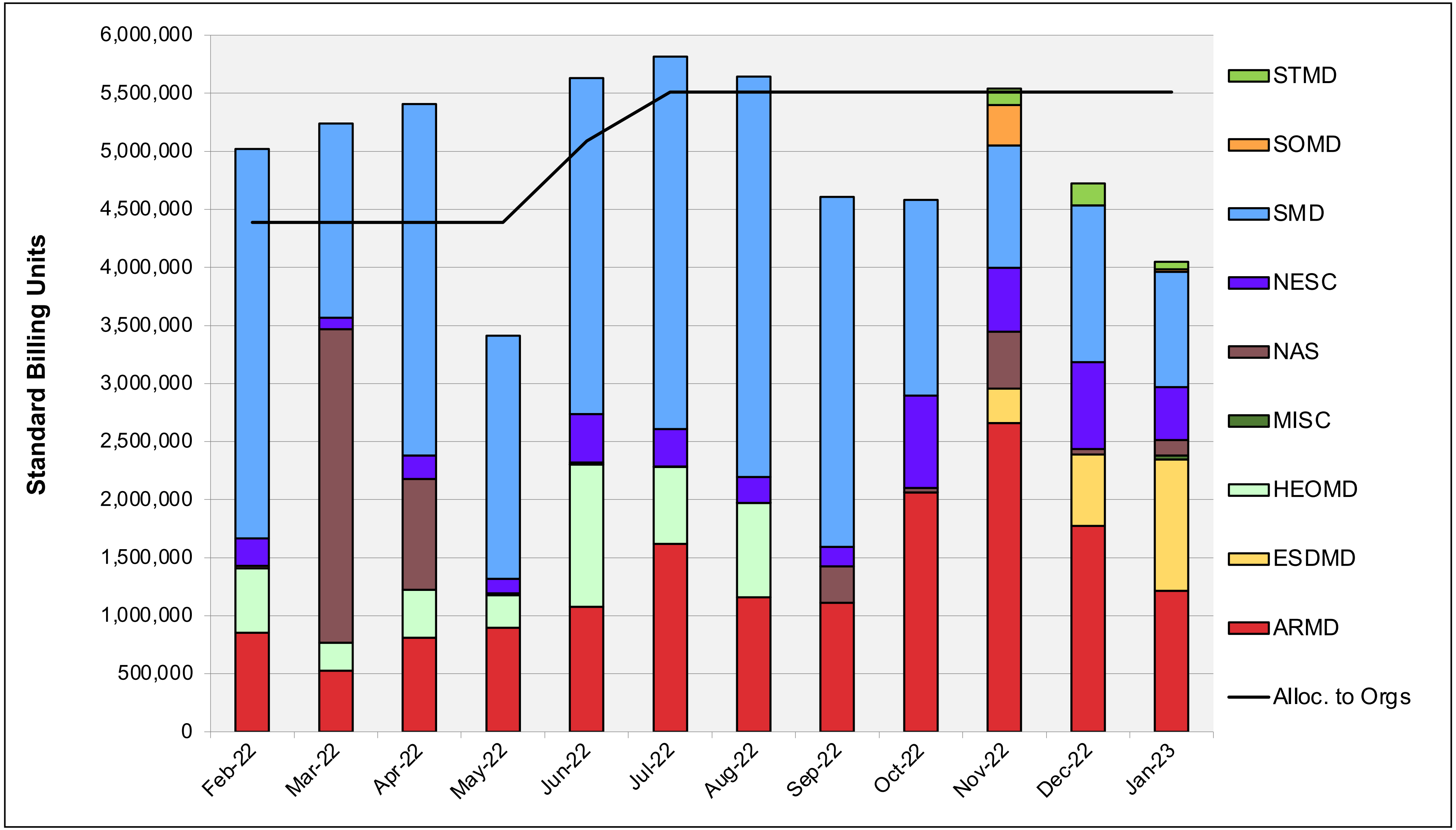
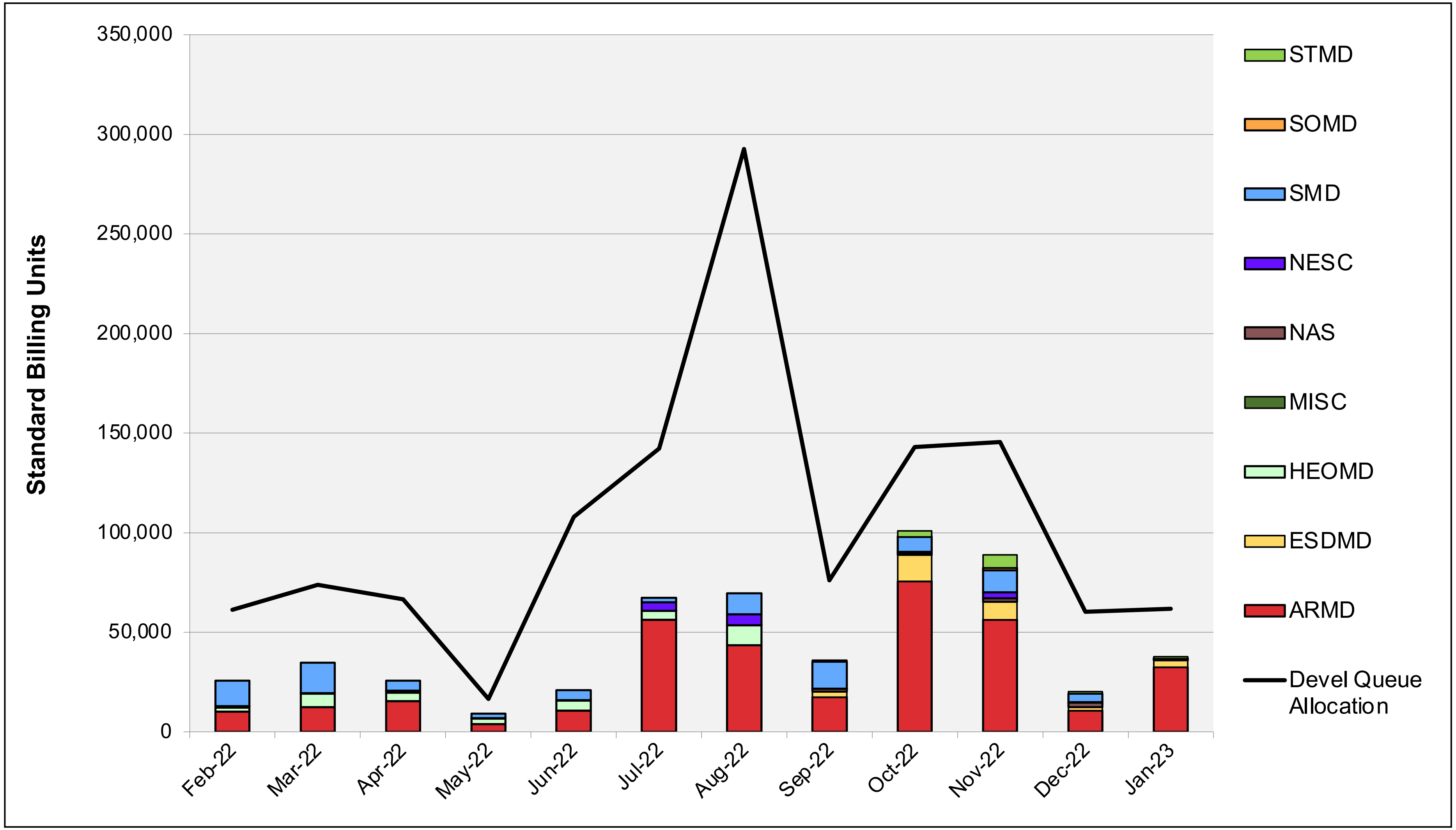


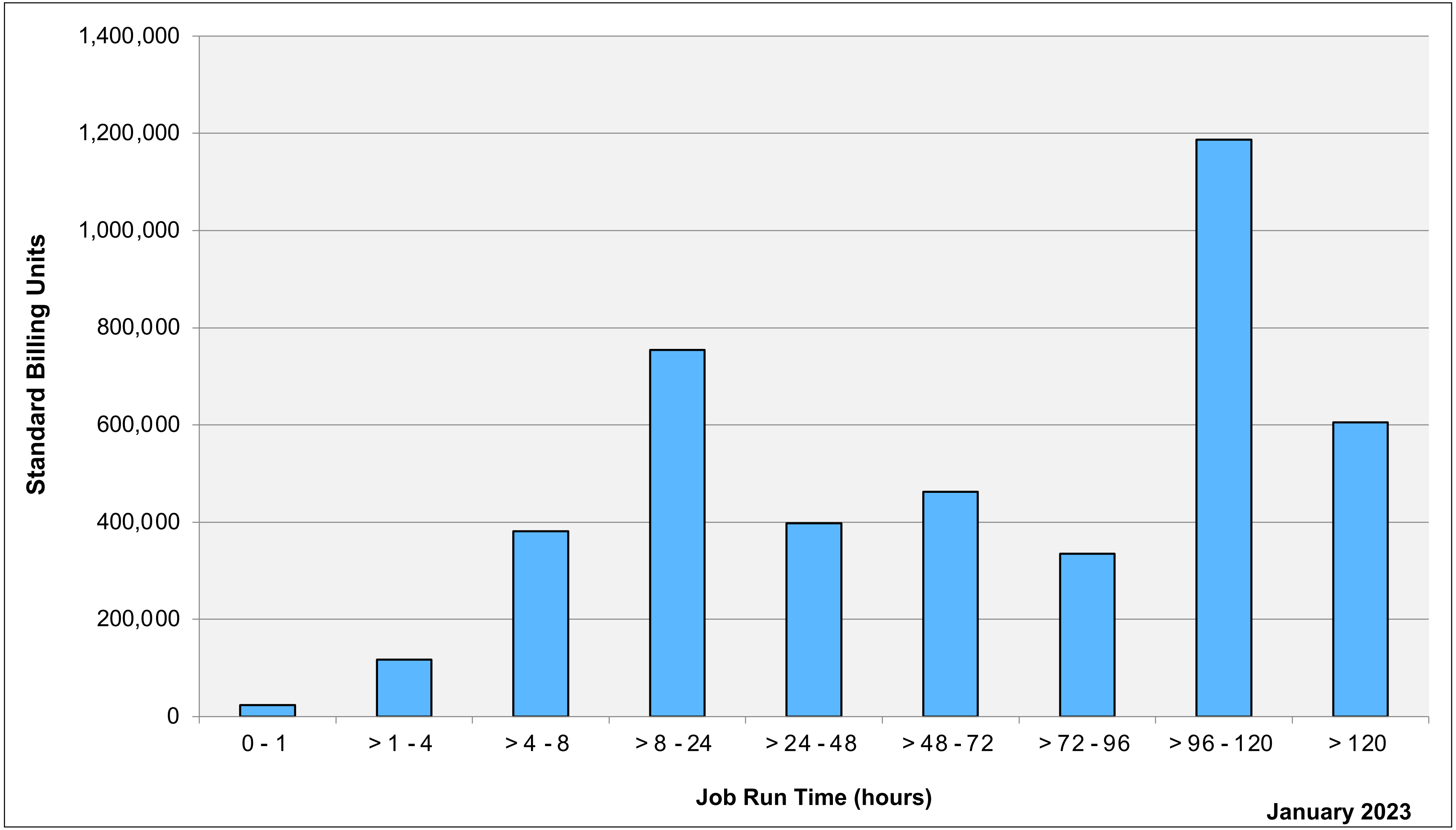
Aitken: SBUs Reported, Normalized to 30-Day Month



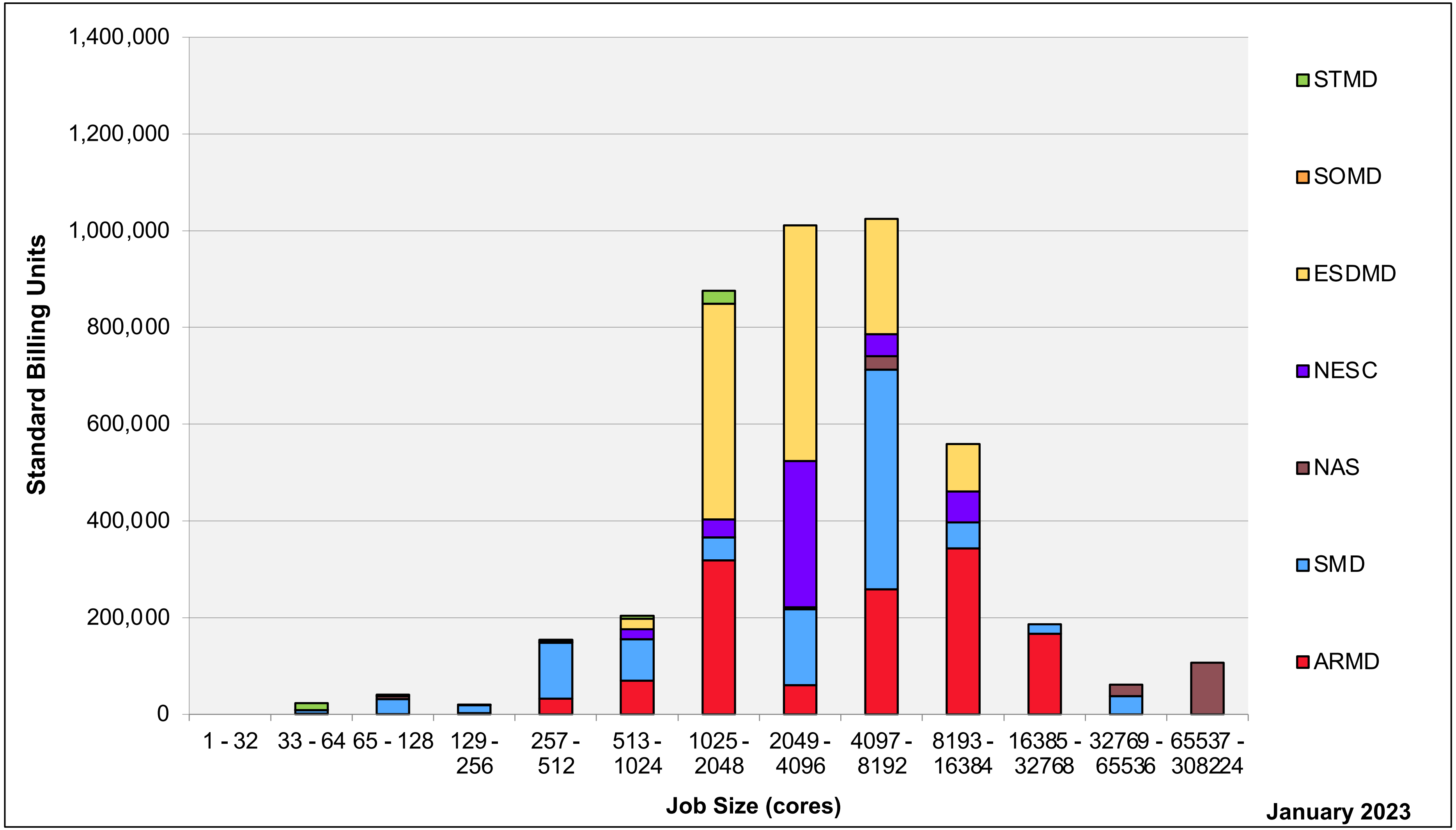
Aitken: Devel Queue Utilization



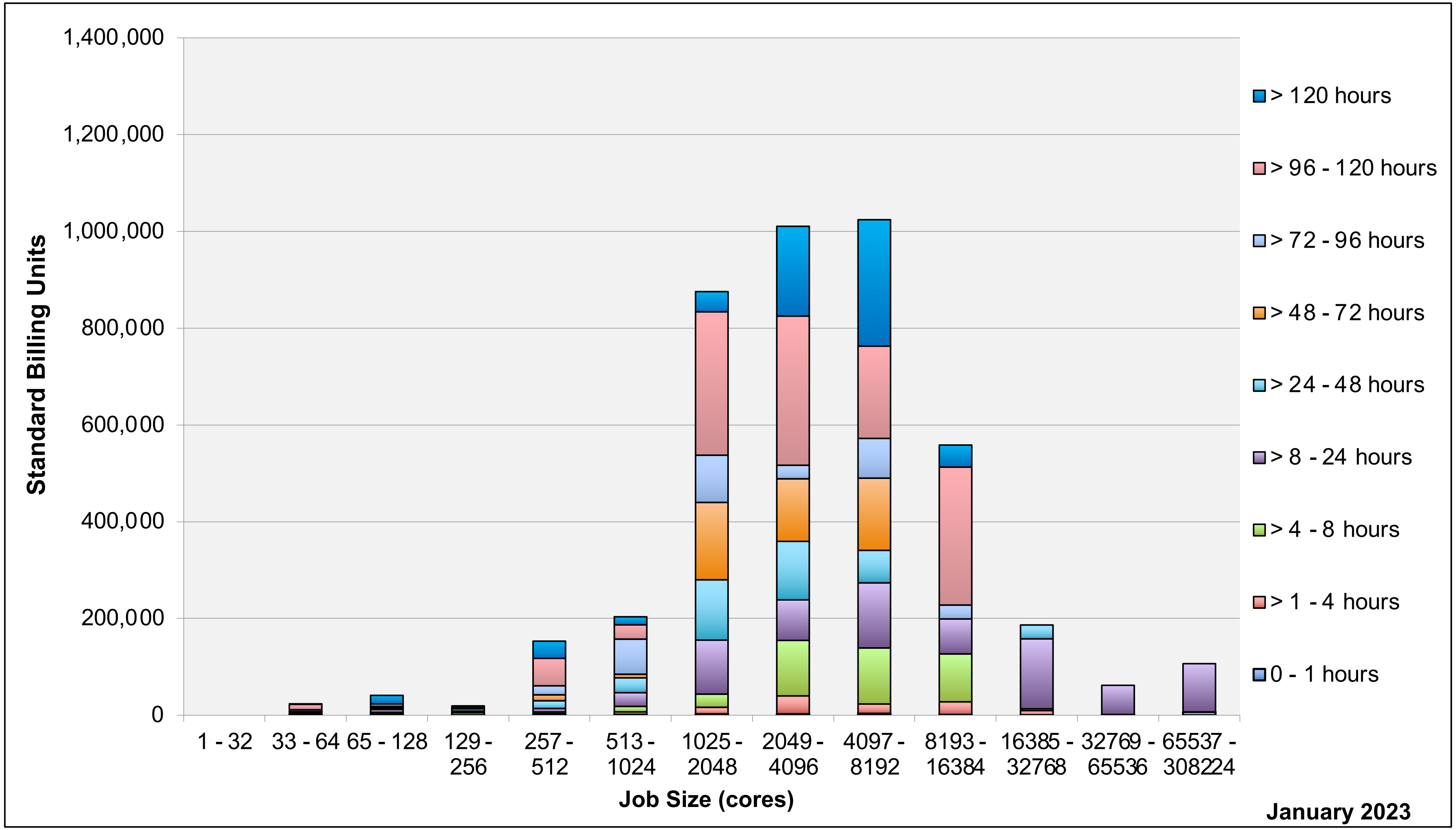
Aitken: Monthly Utilization by Job Length



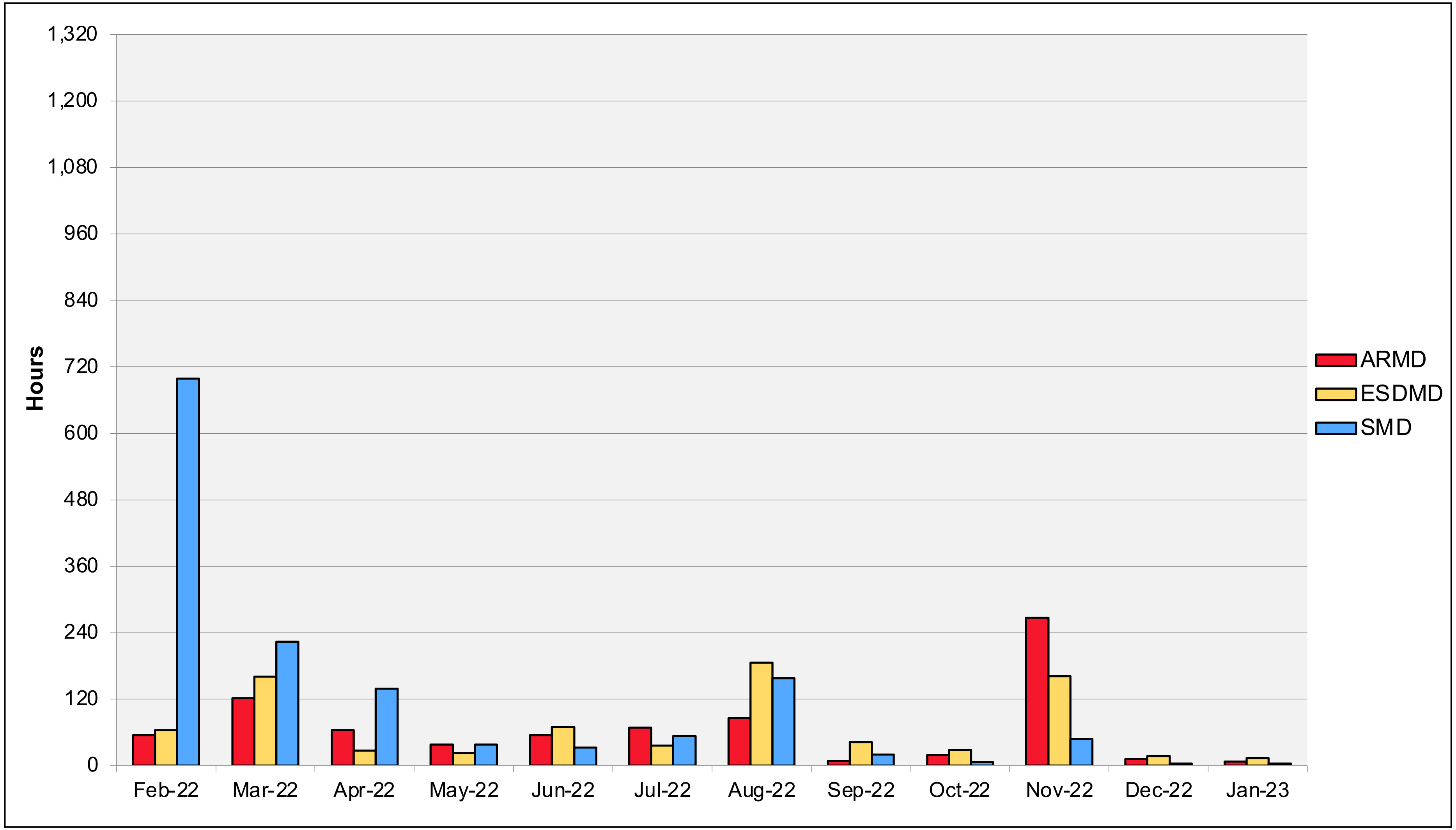
Aitken: Monthly Utilization by Job Size



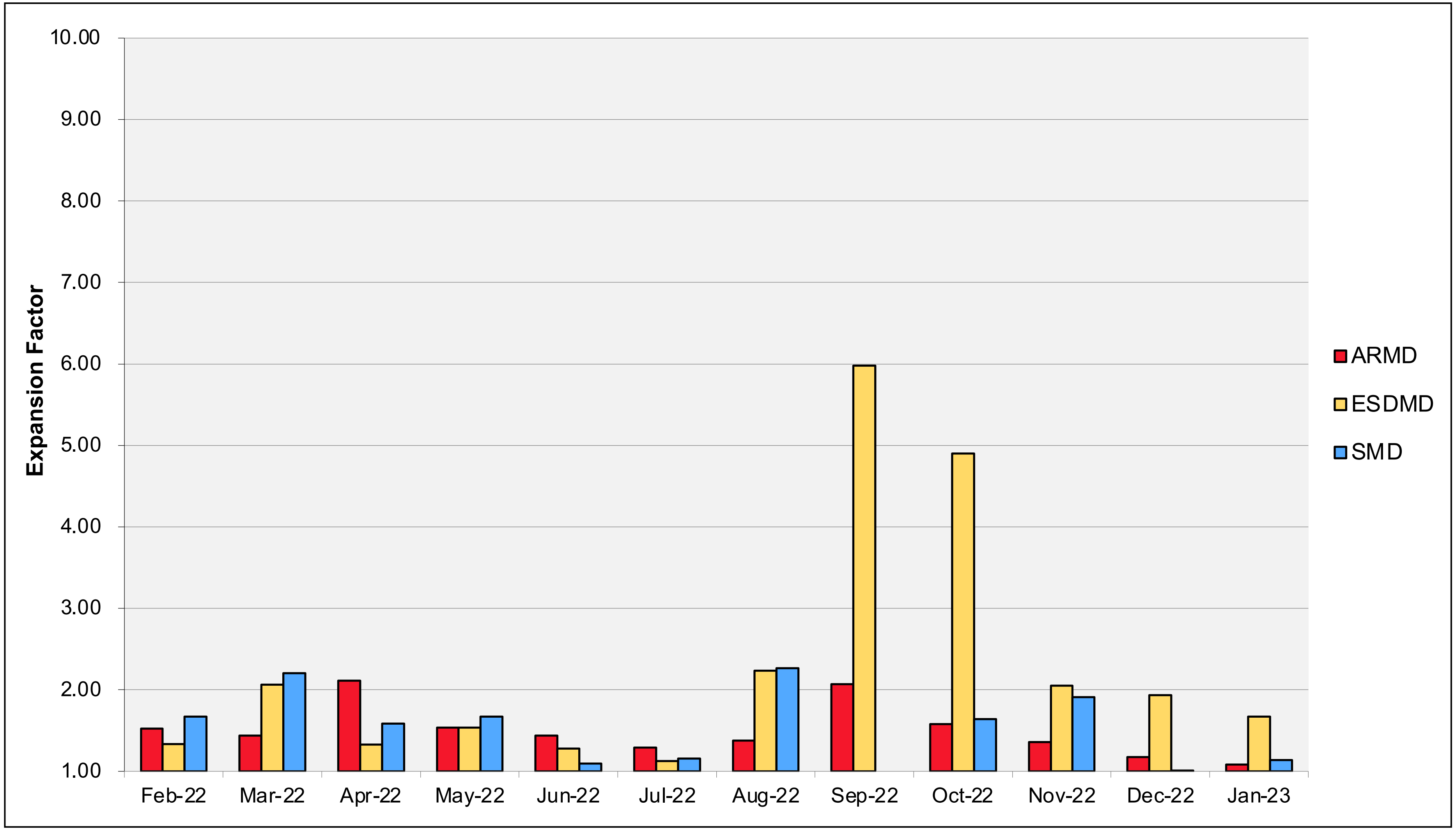
Aitken: Monthly Utilization by Size and Length



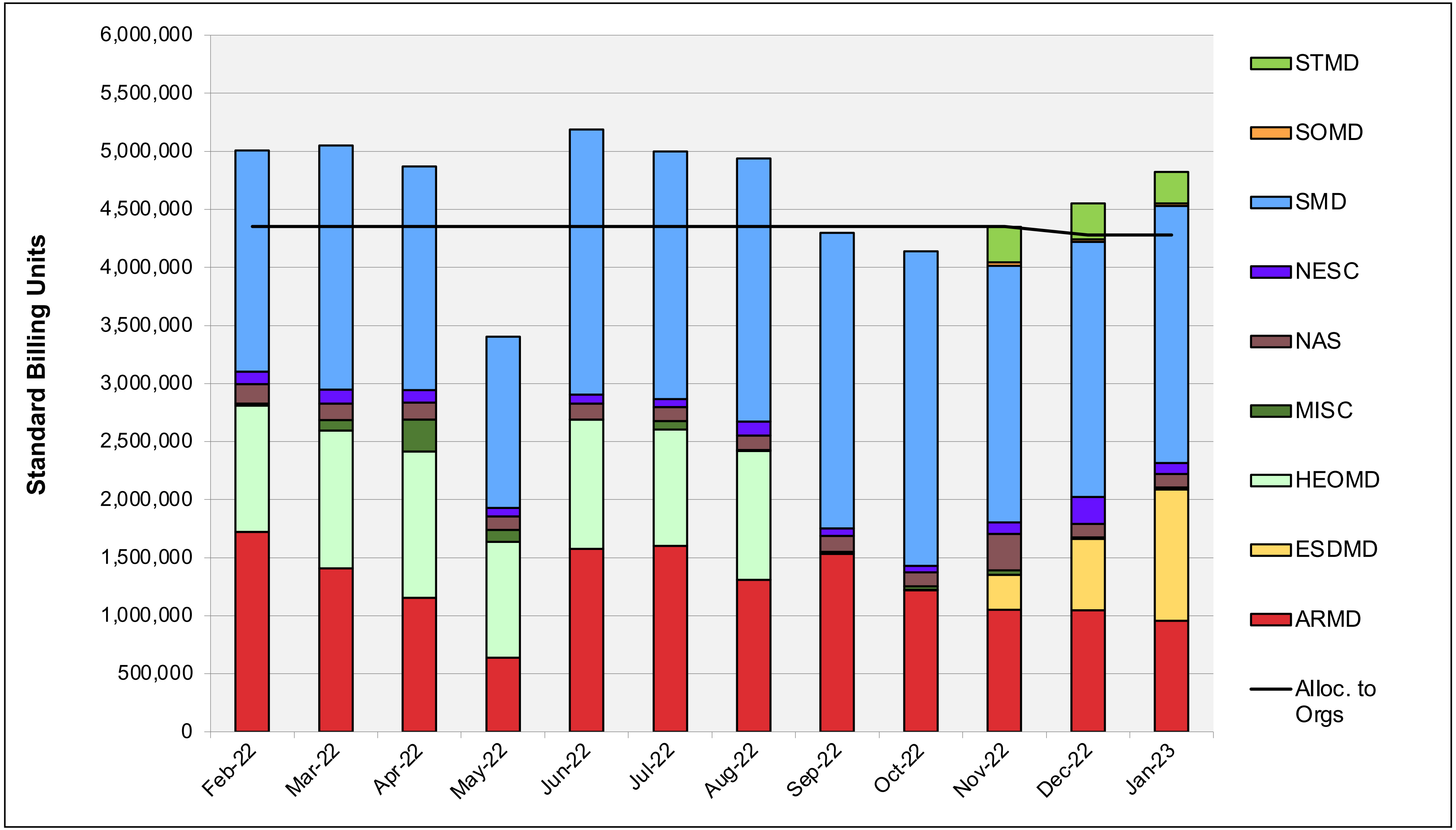
Aitken: Average Time to Clear All Jobs



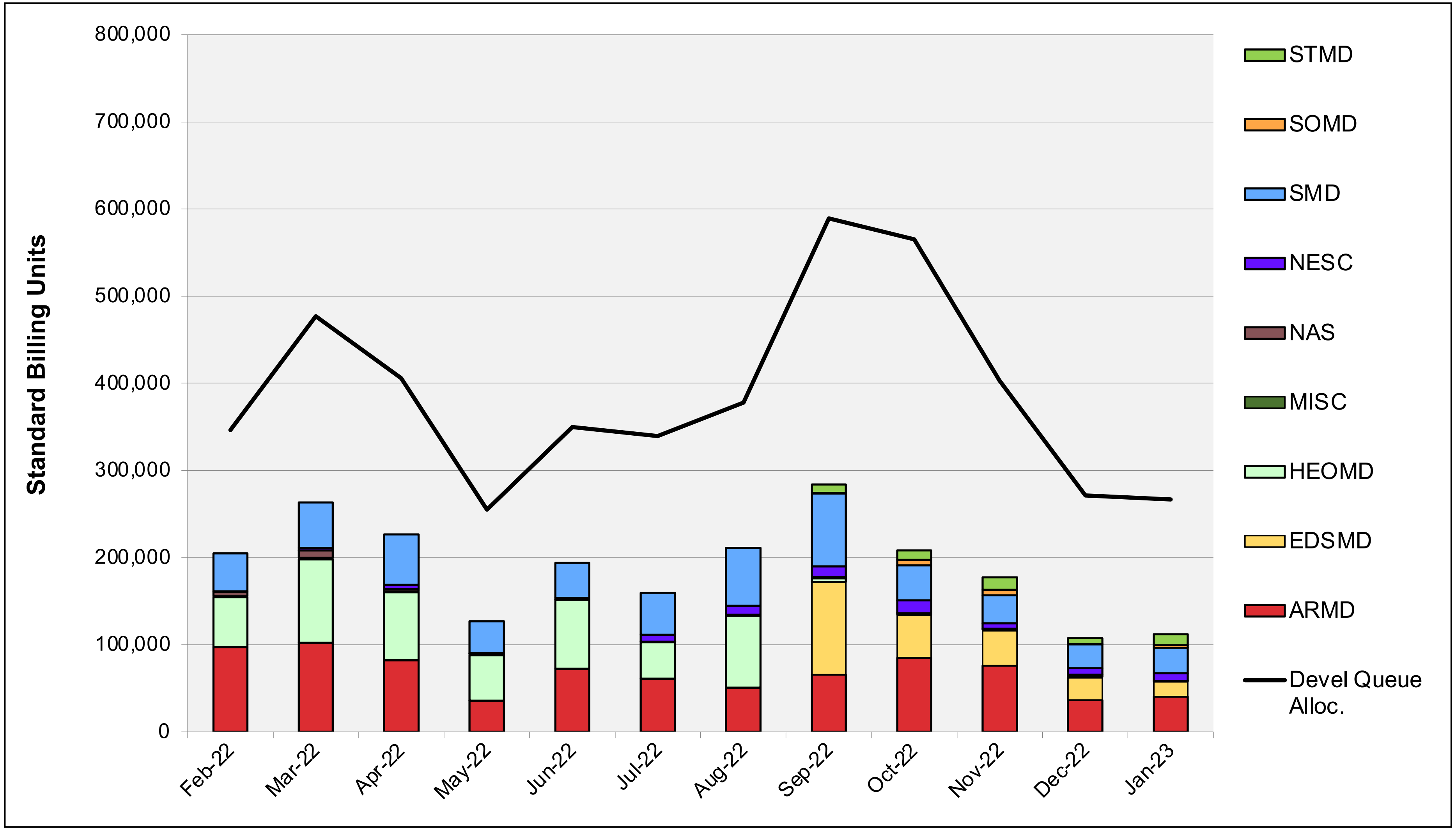
Aitken: Average Expansion Factor



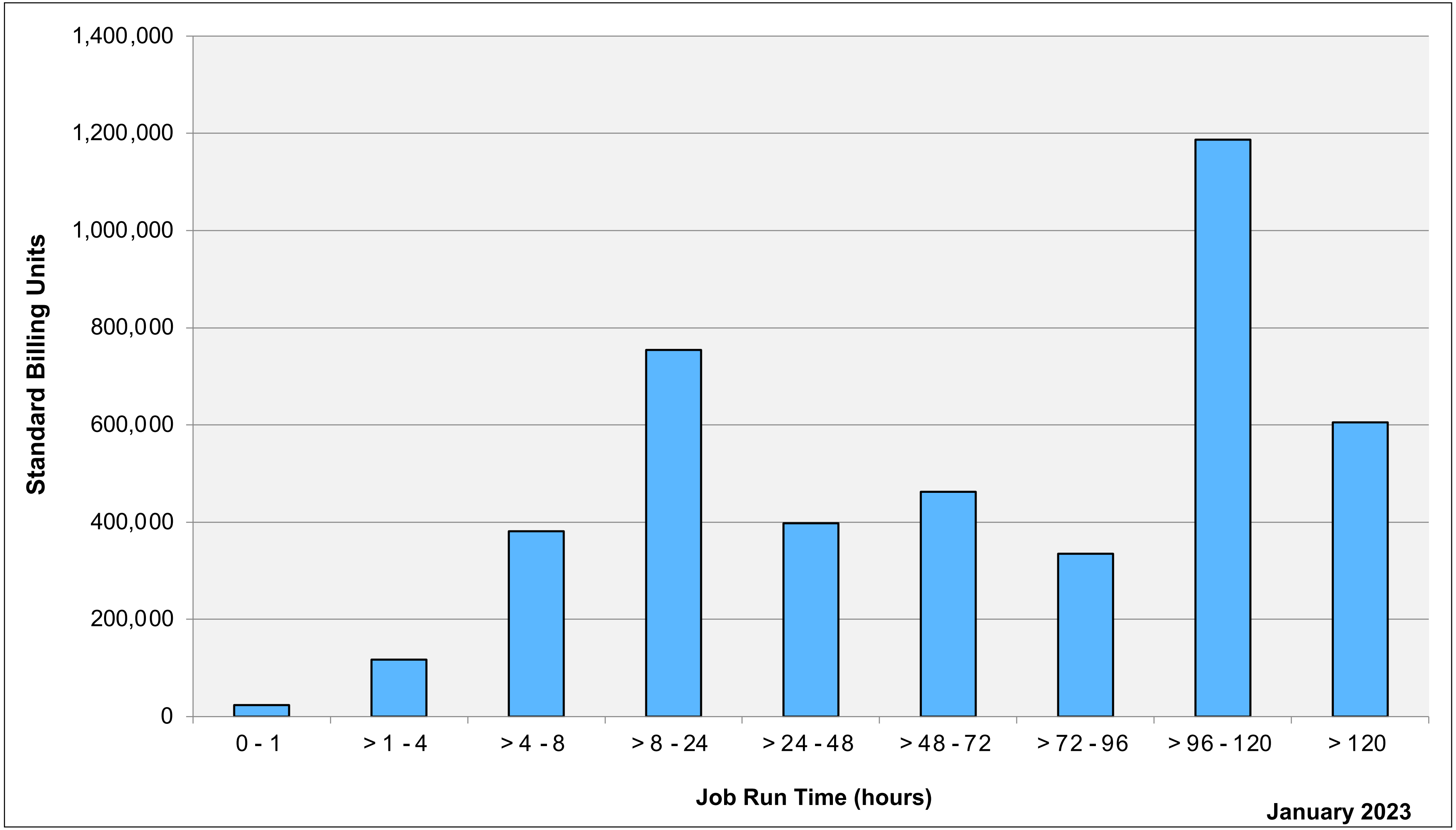
Pleiades: SBUs Reported, Normalized to 30-Day Month



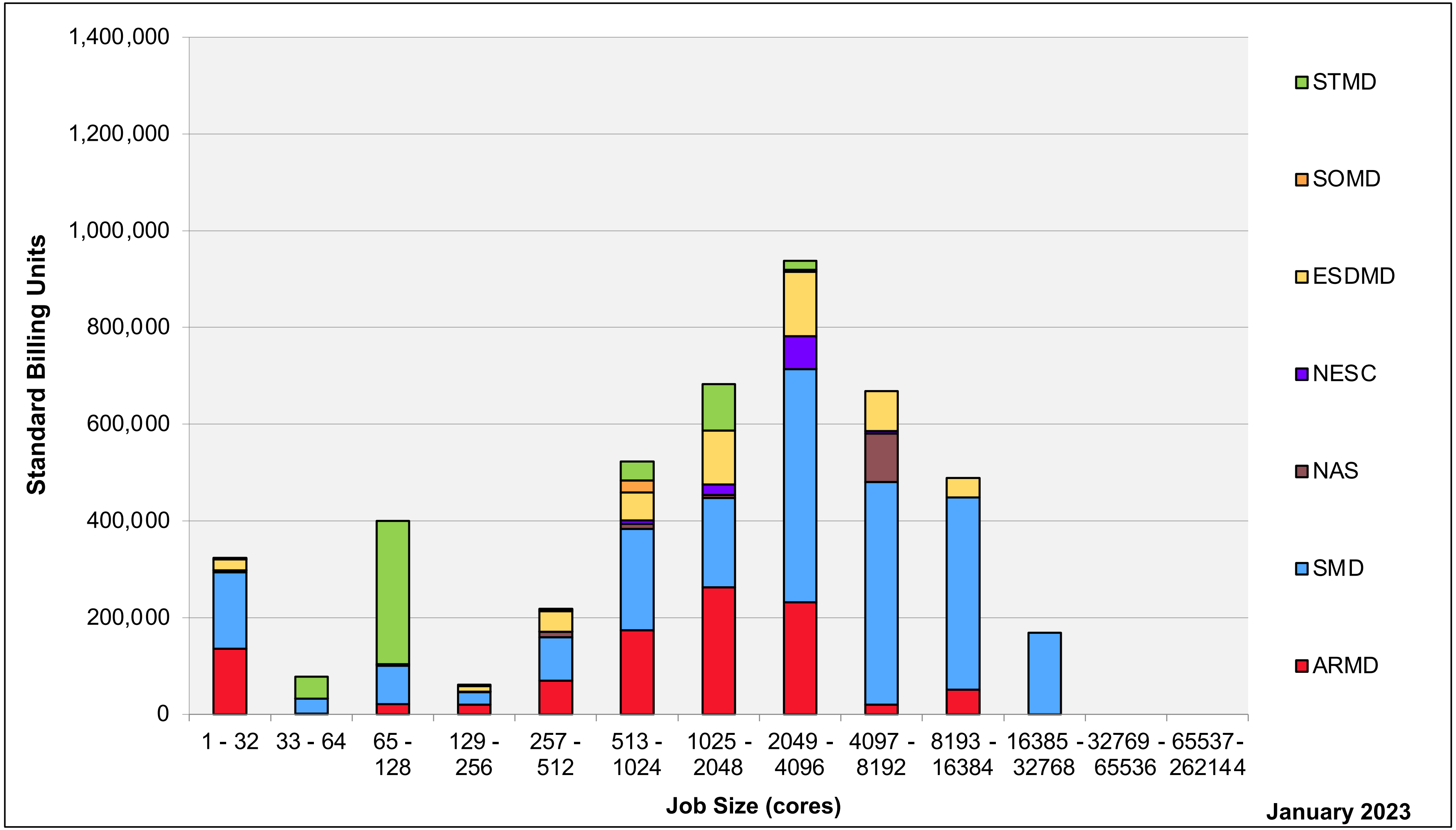
Pleiades: Devel Queue Utilization



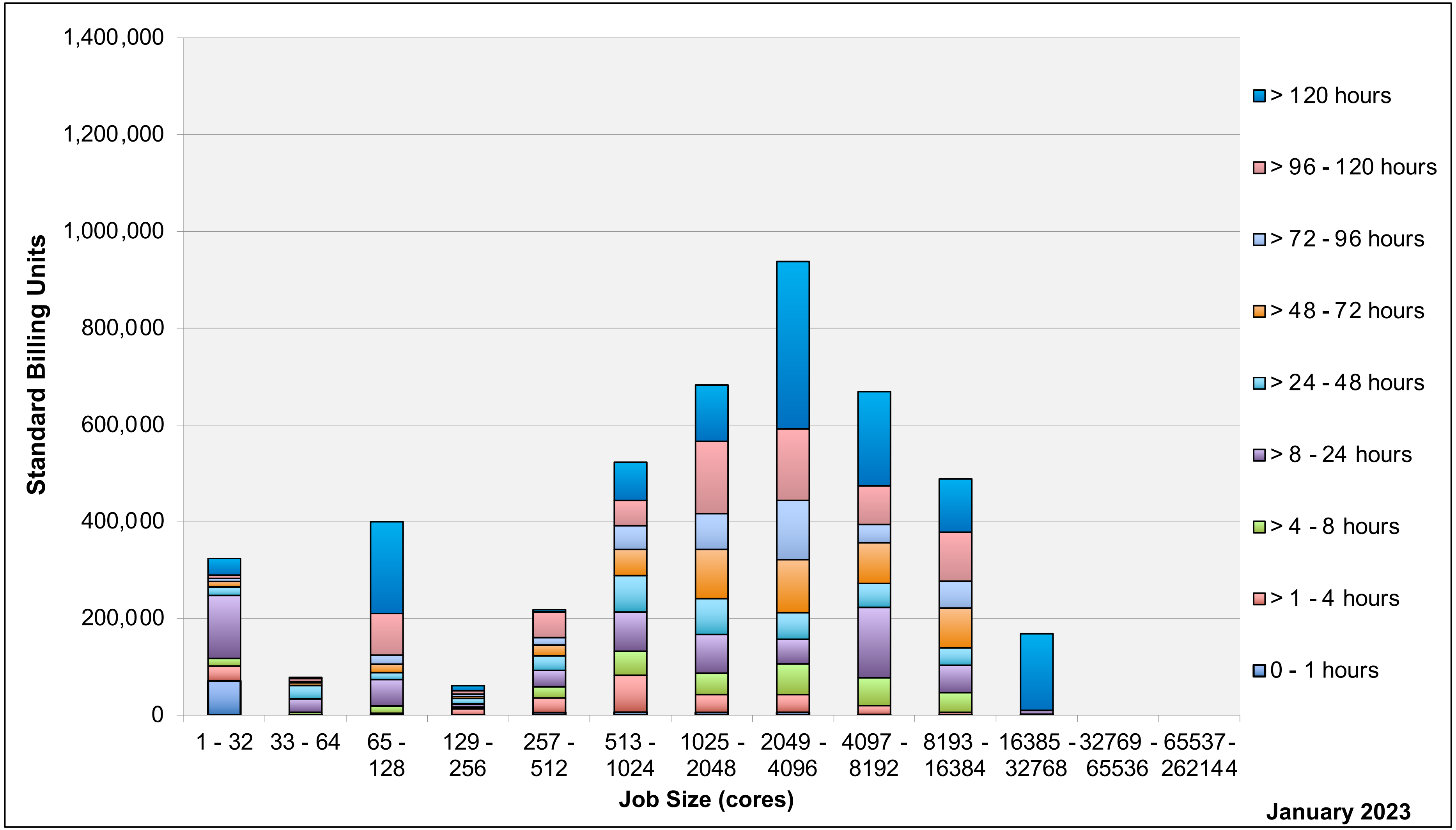
Pleiades: Monthly Utilization by Job Length



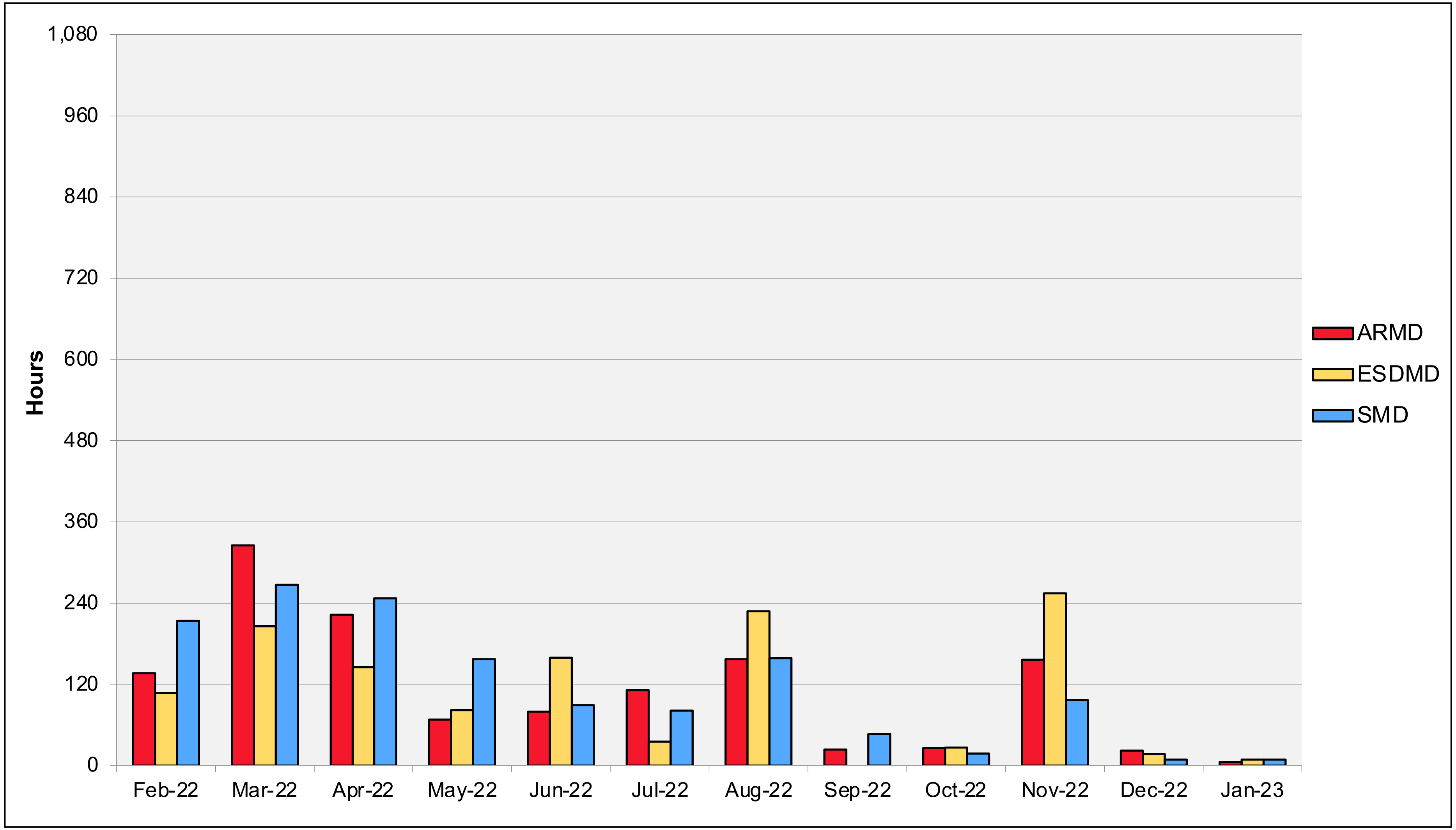
Pleiades: Monthly Utilization by Job Size



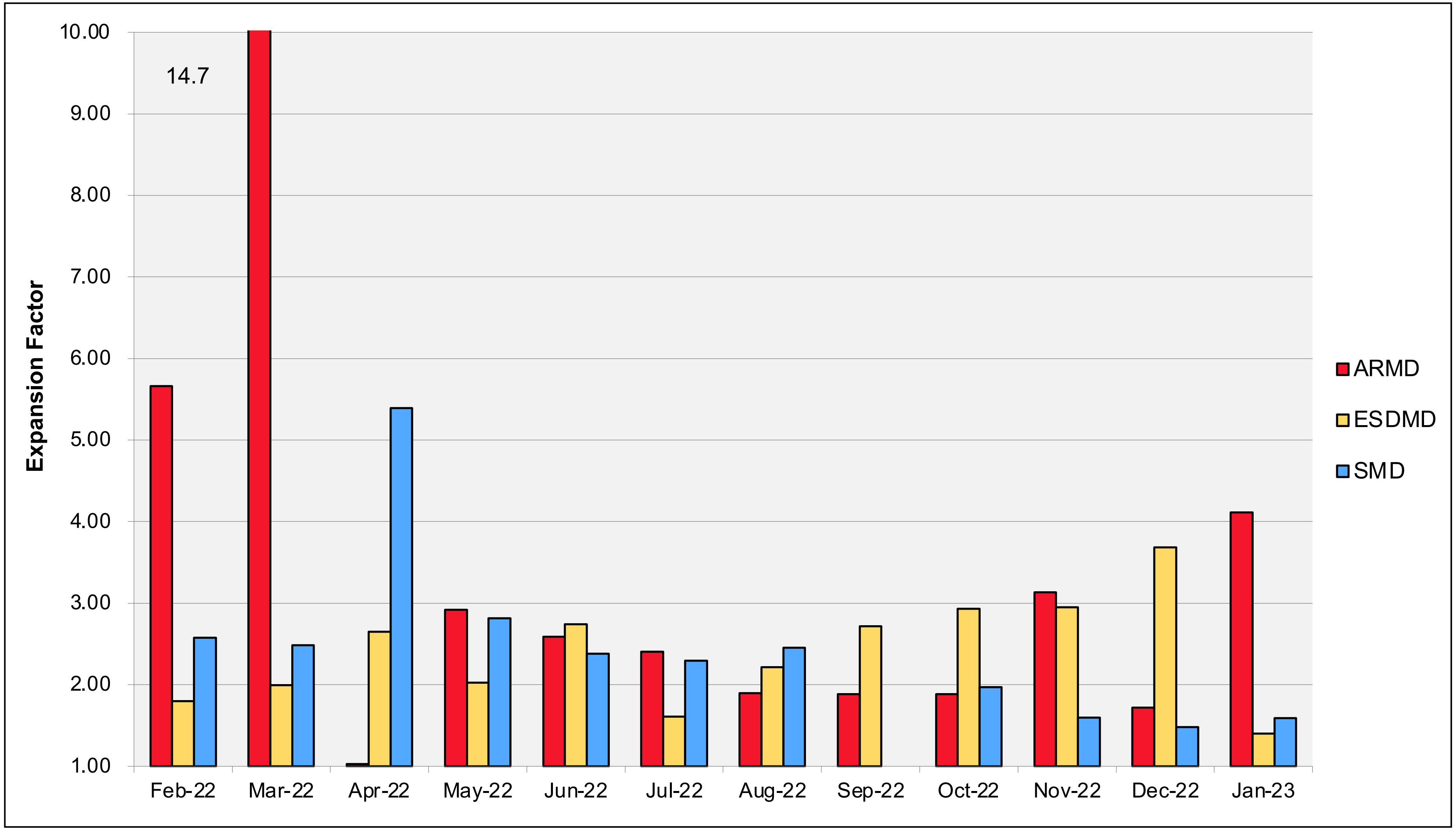
Pleiades: Monthly Utilization by Size and Length



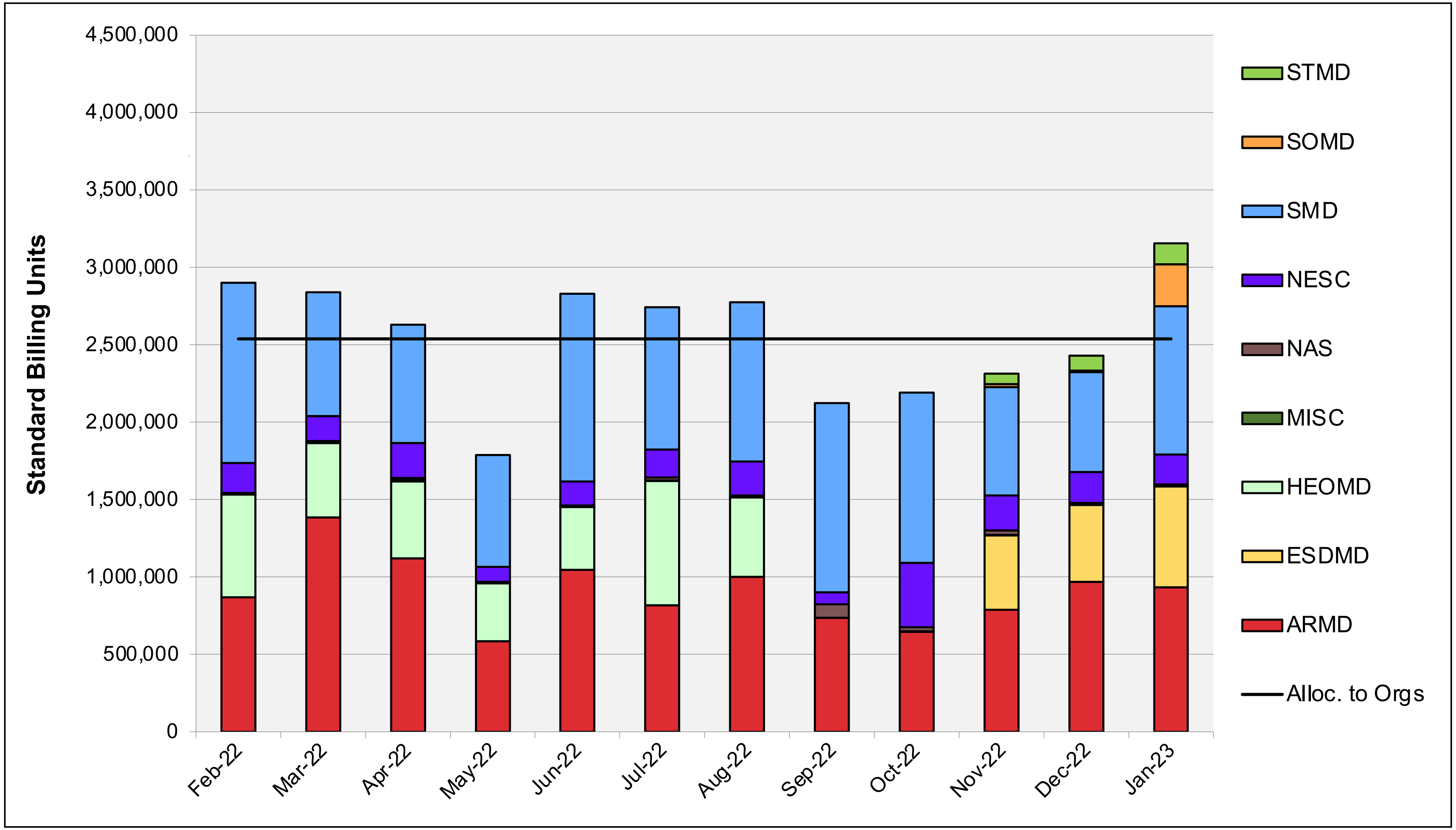
Pleiades: Average Time to Clear All Jobs



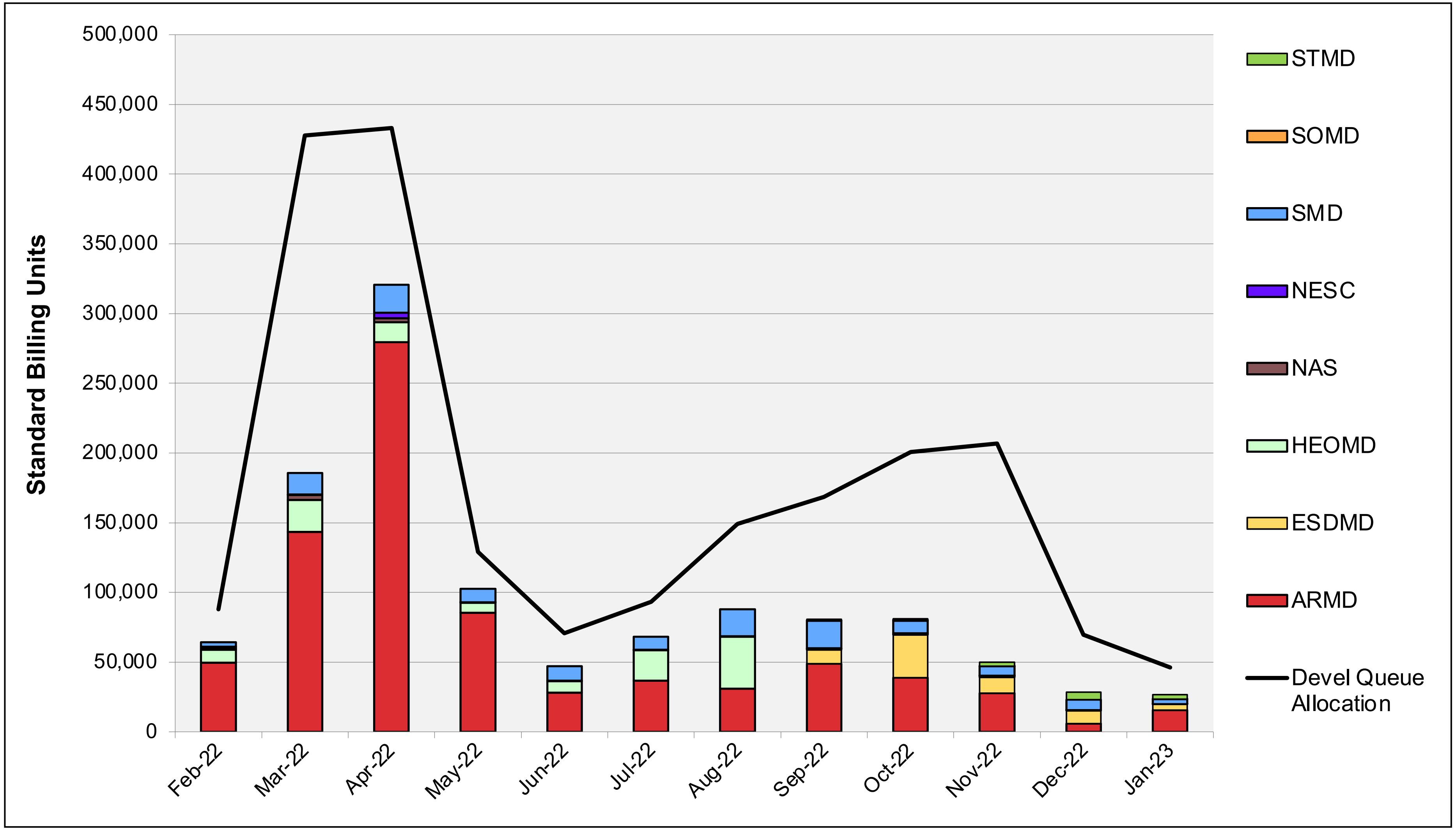
Pleiades: Average Expansion Factor



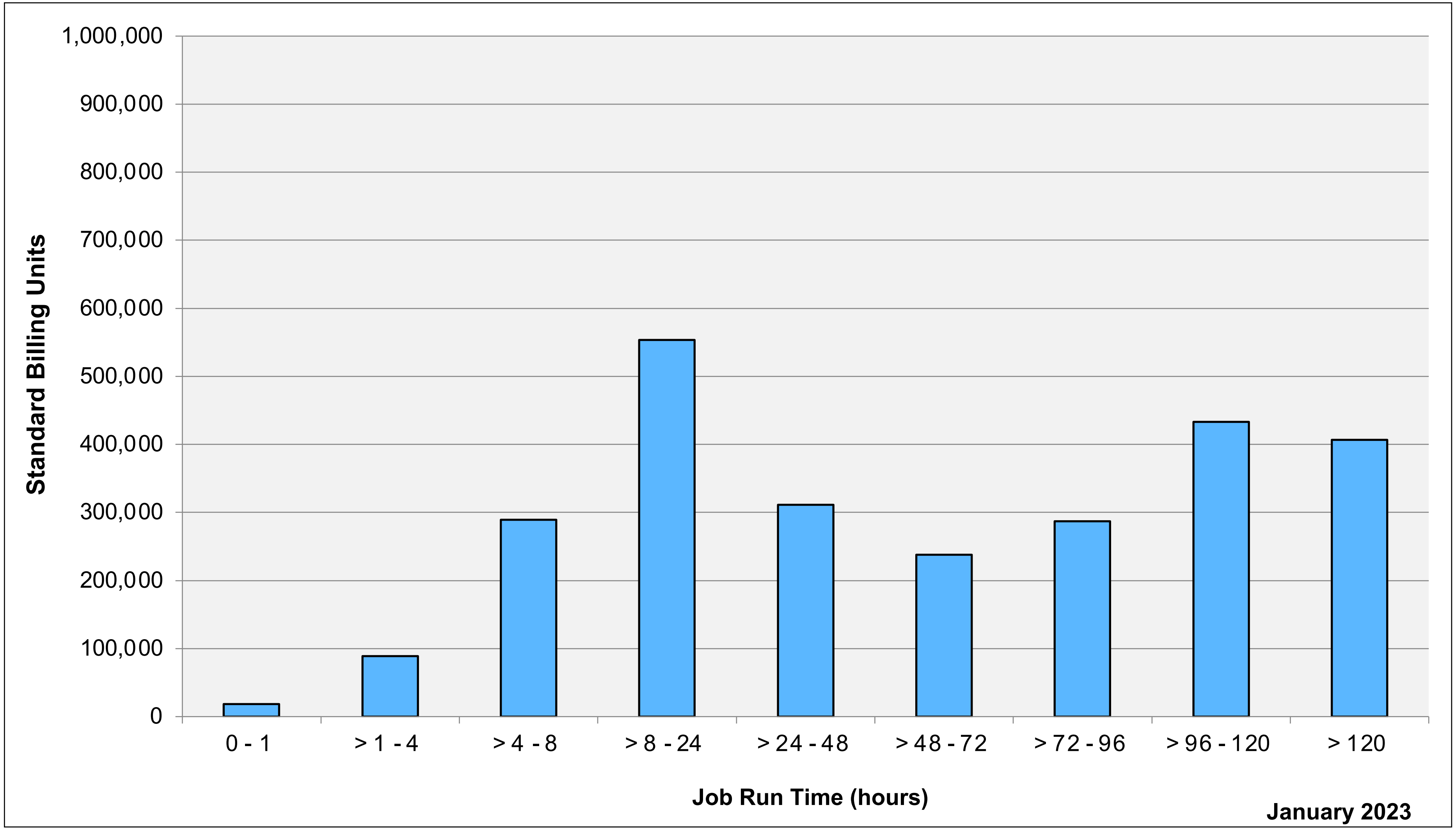
Electra: SBUs Reported, Normalized to 30-Day Month



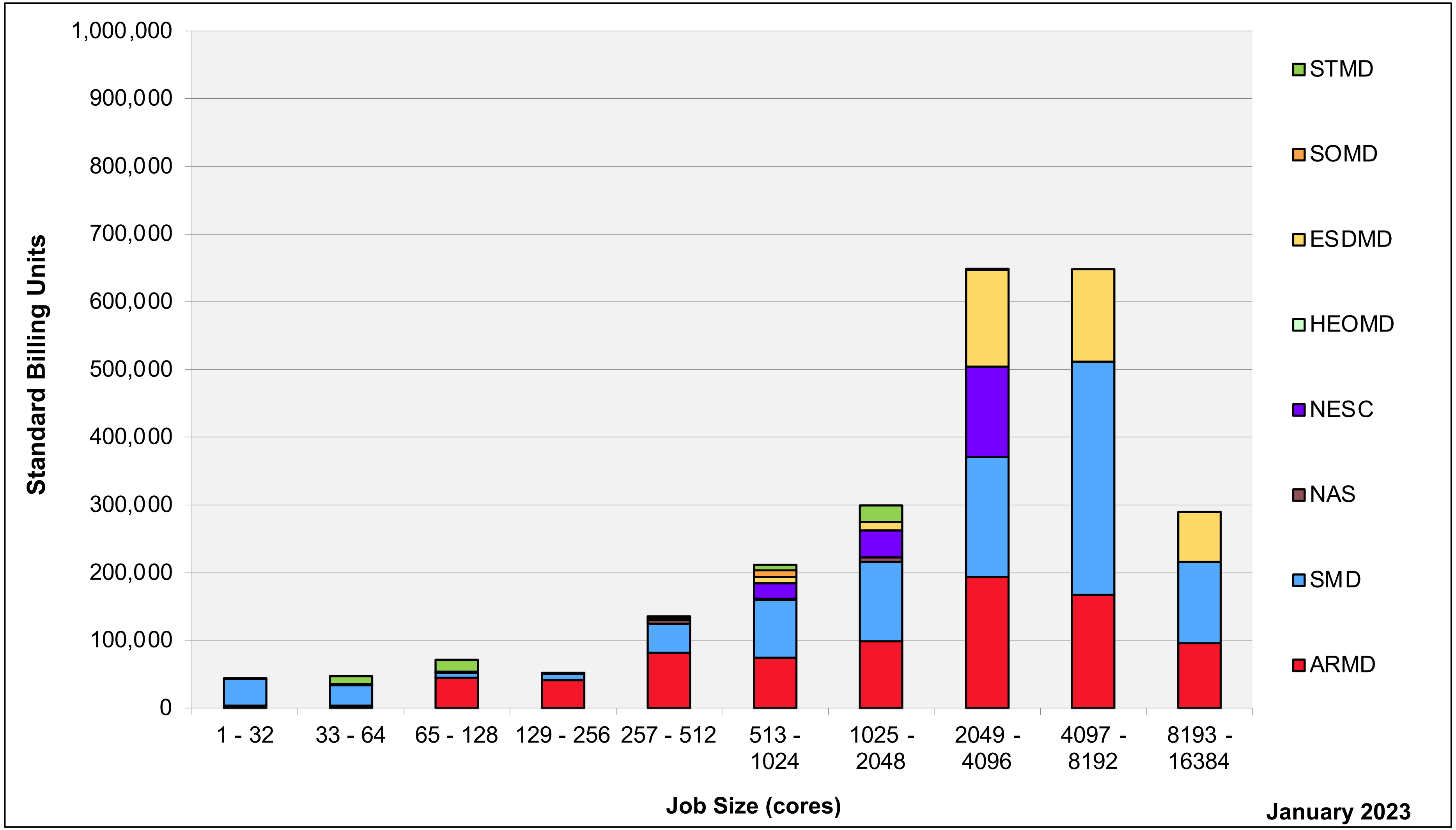
Electra: Devel Queue Utilization



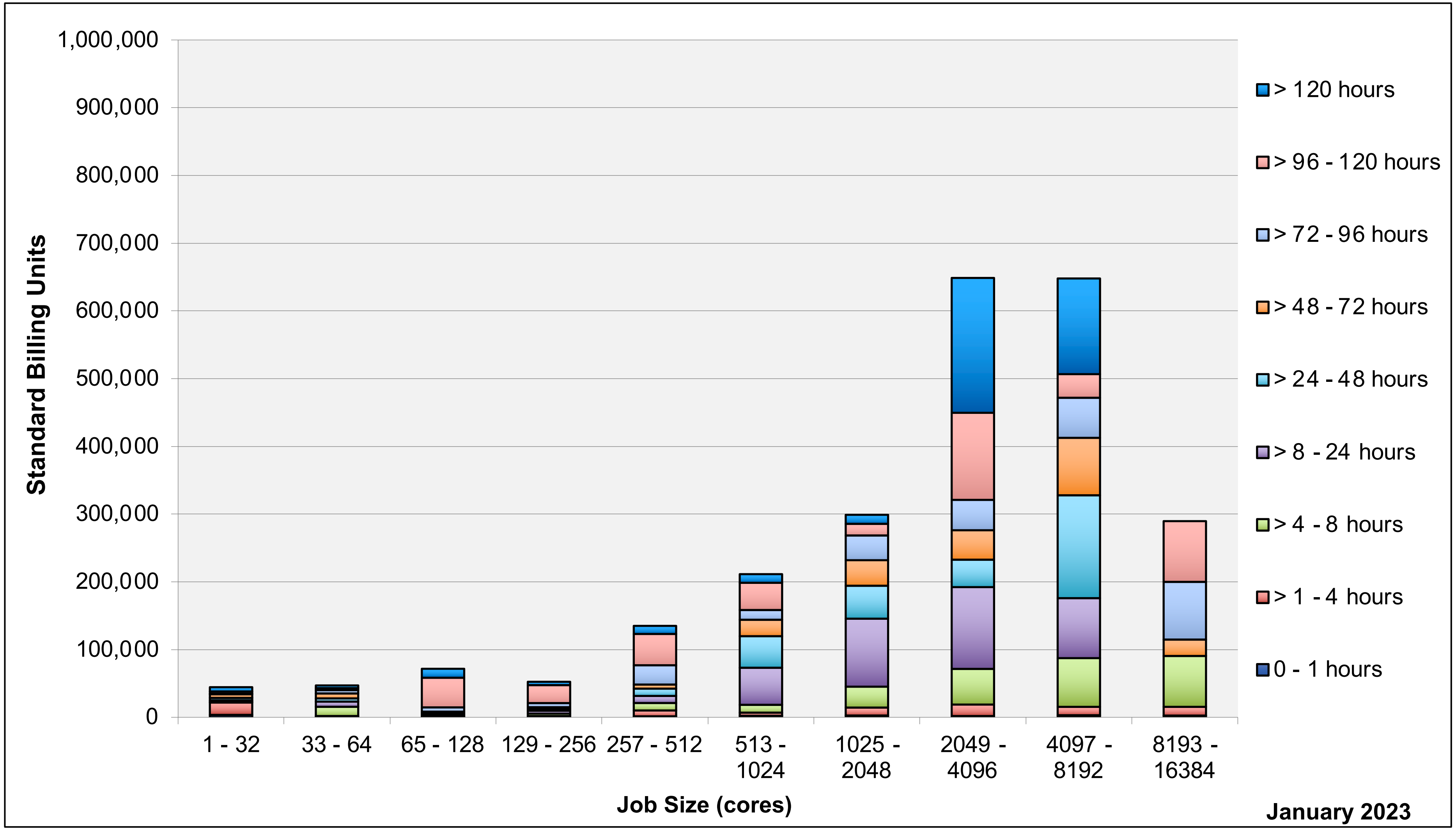
Electra: Monthly Utilization by Job Length



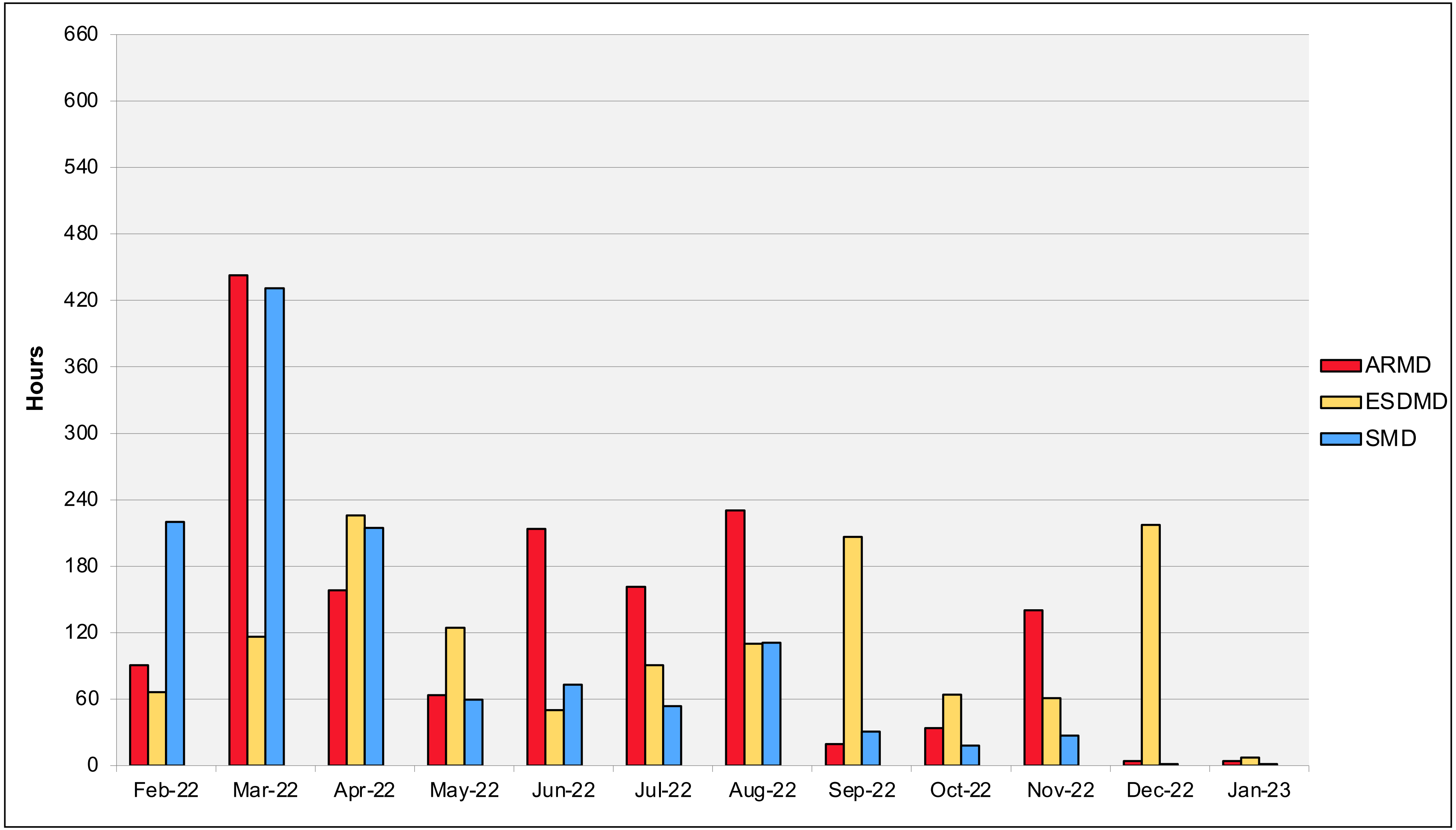
Electra: Monthly Utilization by Job Size



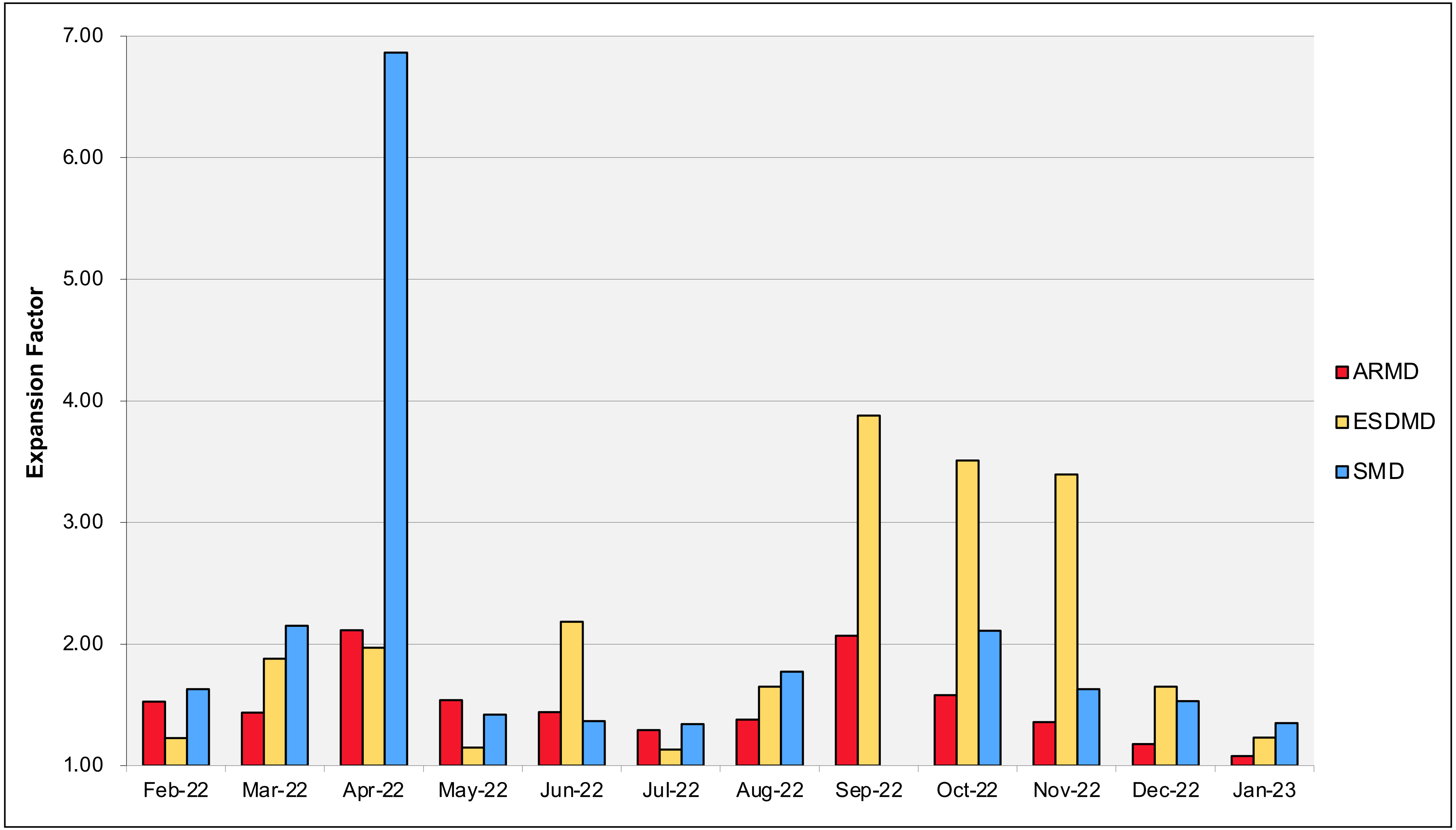
Electra: Monthly Utilization by Size and Length



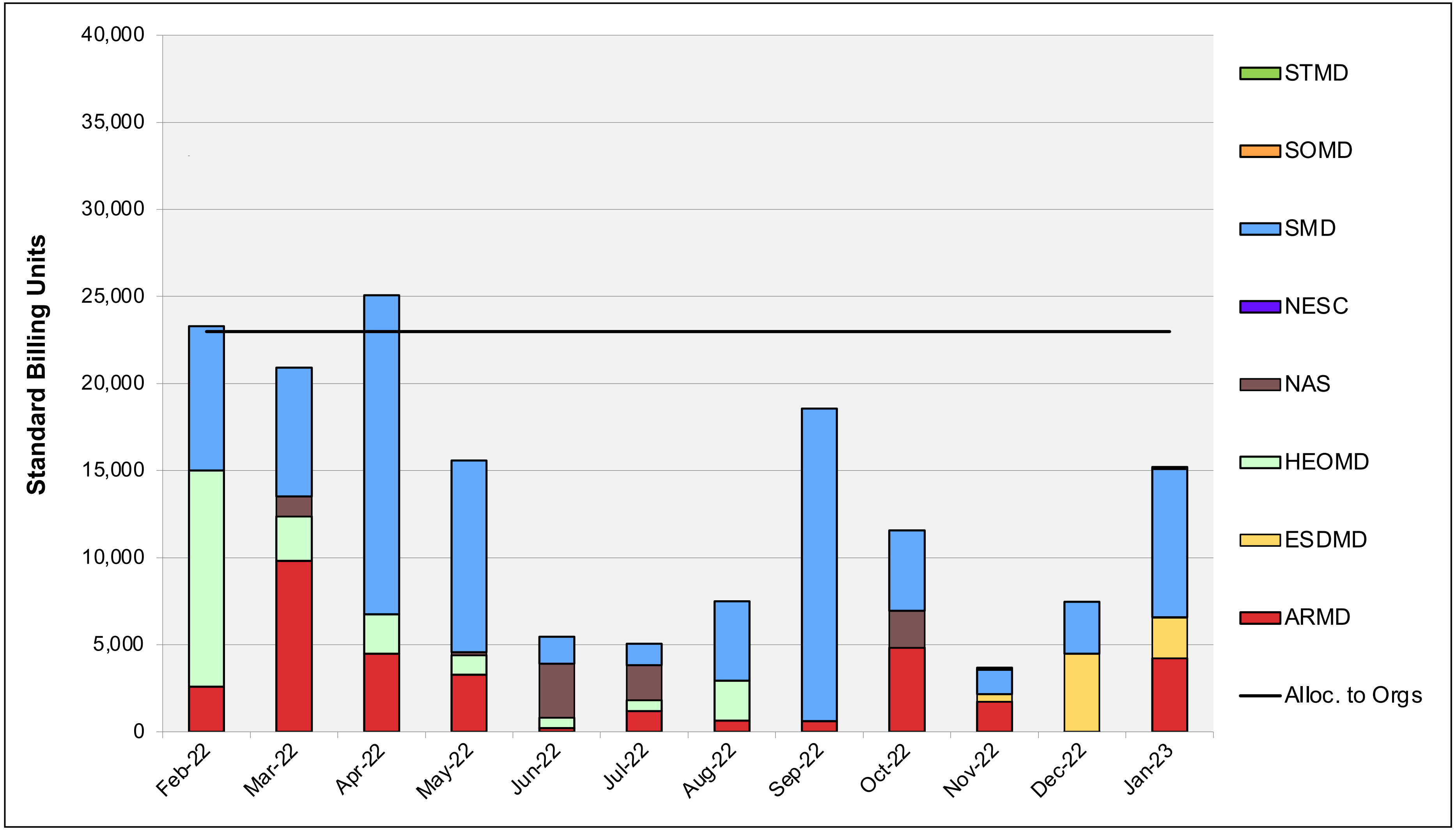
Electra: Average Time to Clear All Jobs



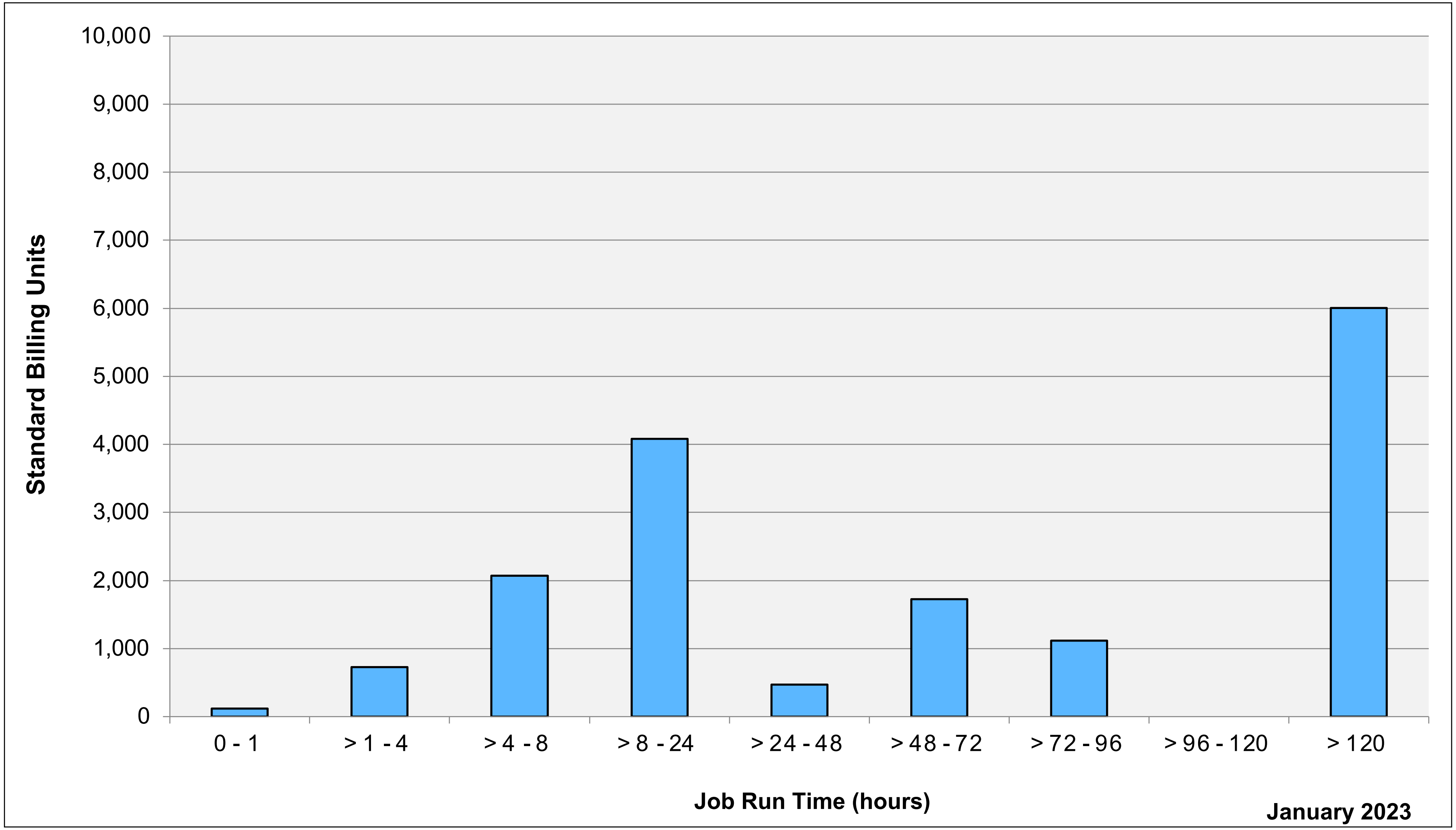
Electra: Average Expansion Factor



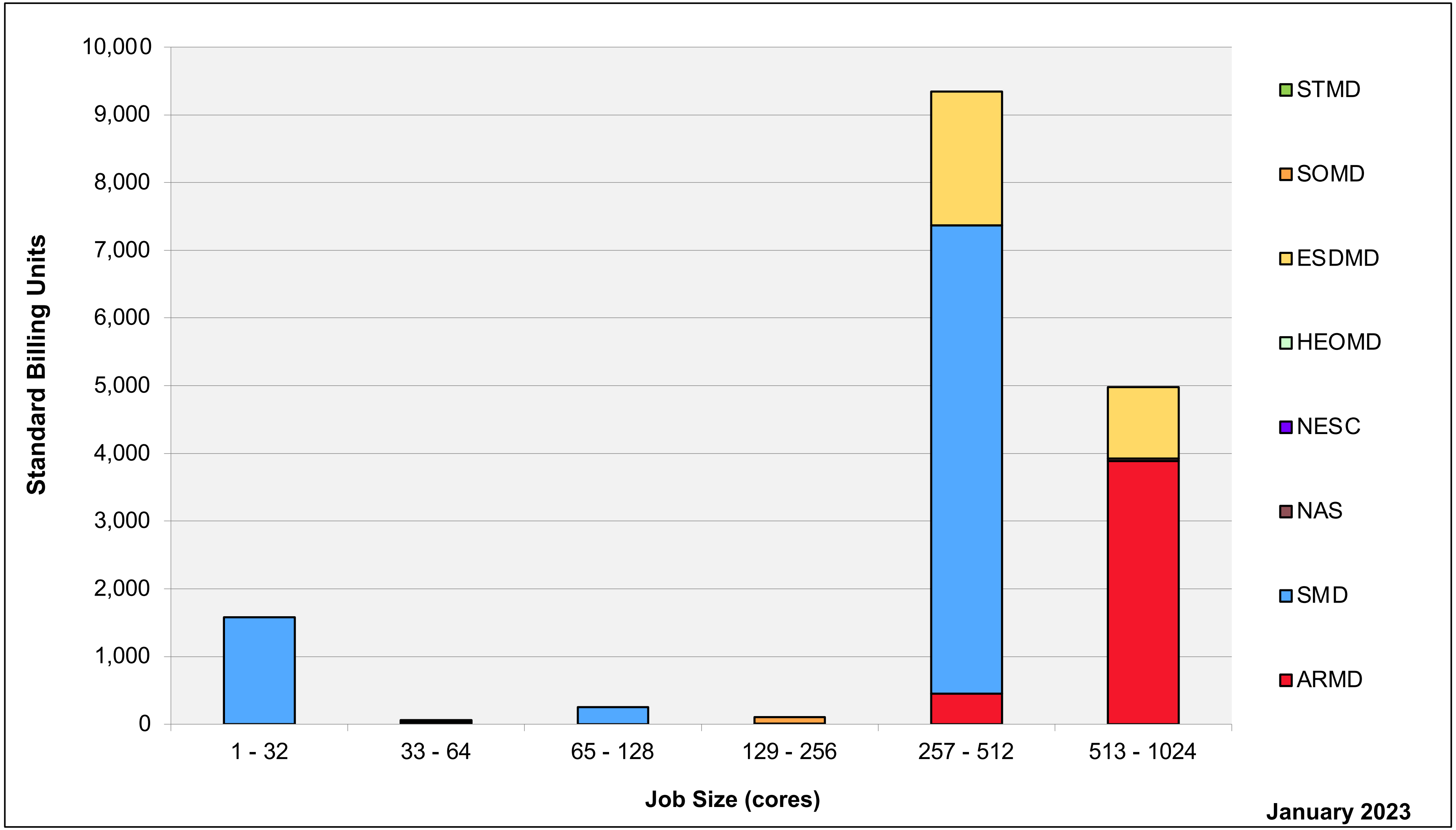
Endeavour: SBUs Reported, Normalized to 30-Day Month



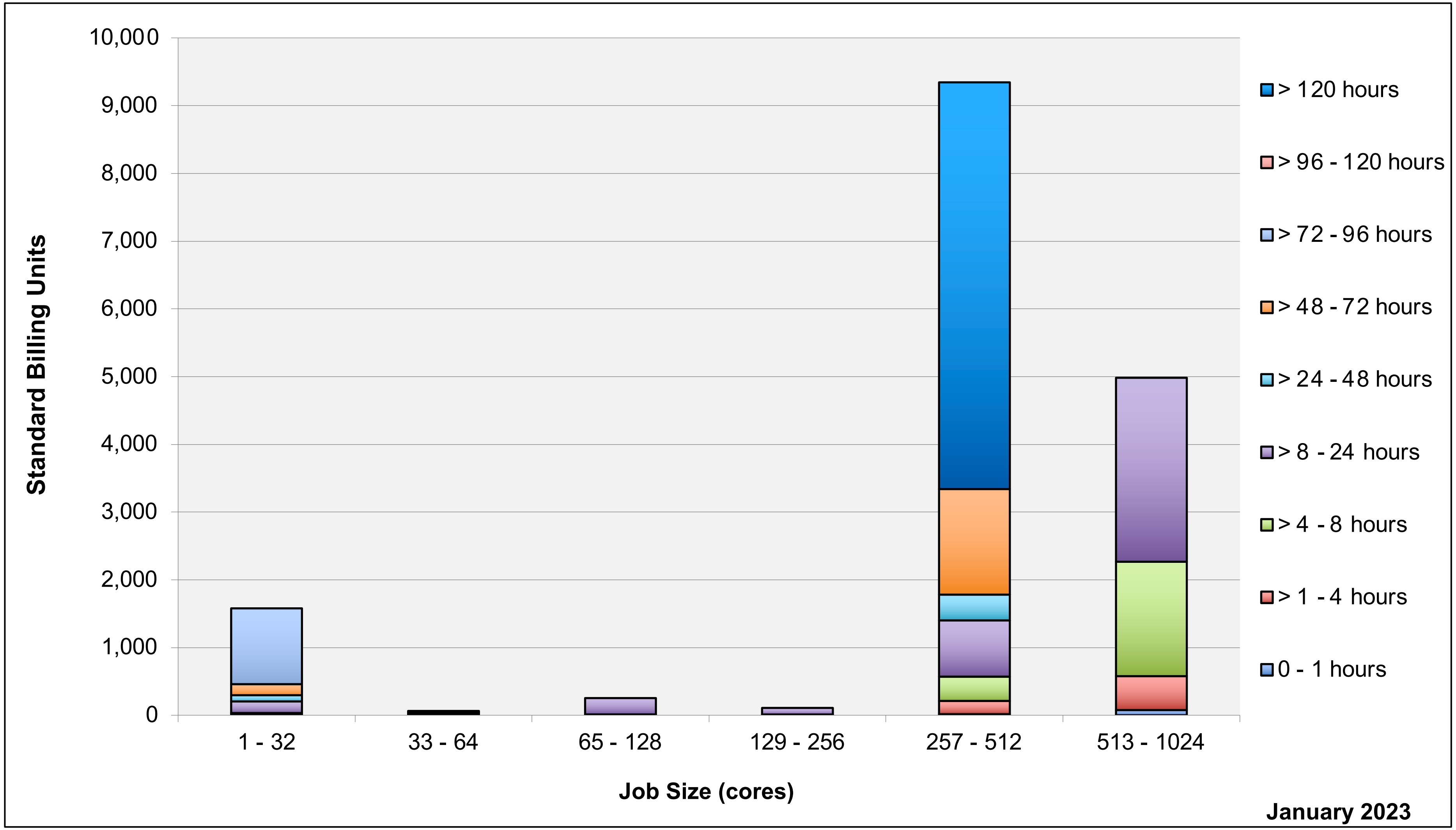
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Expansion Factor